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Federal Shipping Board

ANNOUNCEMENT of the following nominees for the new Federal Shipping Board was made by President Wilson on December 22: William Denman, San Francisco, Cal., for a term of six years; Bernard N. Baker, Baltimore, Md., for a term of five years; John A. Donald, New York, for a term of four years; James B. White, Kansas City, Mo., for a term of three years, and Theodore Brent, New Orleans, La., for a term of two years. These names have been sent to the Senate for its approval, and as soon as ratified it is expected that the new board will make its headquarters in the port of New York.

As this is the first Board of its kind which has been established in the United States with powers for building up and regulating American shipping in the world's trade, it should receive the earnest support and coöperation of all shipping interests. Ample opportunity will be given to the Board to test its authority, and upon its success will rest, in a large measure, the future development of the American merchant marine.

Material and Labor Markets Hamper Naval Construction

THE amount of shipping now under way at navy yards in the United States shows an increase over previous years, both as regards the number of vessels and their total value. The greatest difficulty has been experienced, however, in avoiding serious delays in the construction of these vessels, due to the abnormal conditions existing in both the material and labor markets. According to statements made by the Chief of the Bureau of Construction and Repair in his annual report to the Secretary of the Navy, there is available only a limited number of skilled men in the shipbuilding trades, and, as these have been in great demand in the various private shipbuilding establishments where an unprecedented volume of merchant tonnage is under construction, it has proved impracticable to obtain men to increase the navy yard forces to the point warranted by the large amount of work in hand. In fact, difficulty has been experienced in avoiding serious depletion of the forces already employed, as the opportunities existing in private plants for increased earnings through overtime work form an inducement which goes far to offset that possessed by government employment. This condition promises to become more acute when the large volume of work involved in the new naval program is taken in hand, as there appears to be no reason to look for a decrease in the demand for additional new tonnage for the merchant marine.

"Old Mac's" Advice

ELSEWHERE in this number will be found the first of a series of articles which deal with the practical side of drawing office work. "Old Mac" exemplifies the capable, practical old ship draftsman, who knows from hard knocks in the past that finally the design of a ship is a compromise and that to make any kind of headway in actual construction what is called "good practice" must be accepted and experimental analysis discouraged. He does some things well enough that the man who tries to analyze cannot do at all, because the problem is too complex, life is short, and a ship is built for a profit.

The college boy who comes into the office worries about things with which he will never be intrusted. The luxury of experimenting and theorizing is not his. "Old Mac" serves the very good purpose of holding down the young fellow and forcing him to accumulate enough of this "good practice" so that he can be a good assistant until his mature judgment fits him to take on heavier work. "Old Mac" is jealous of his practical knowledge, and, as he says, it is not to be found in books, so let us listen to what he has to say.

Readers of this Magazine Threatened with an Unjust Tax

ON December 9 Representative Randall of California introduced in Congress a rider on the Post-Office Appropriation Bill, which proposes to apply the zone system, as applied to parcel post, to all second-class mail matter.

If this bill is enacted, the result will be that instead of the present flat rate of one cent per pound for postage, for the delivery of this magazine to its readers in any part of the United States, the postal rate will be based on the distance of transportation of the magazine. In other words, American citizens who live remote from publication centers will be taxed as high as 6 cents per pound postage on all of their magazines, periodicals and newspapers.

We cannot believe that any of our readers will willingly submit to such an unfair and unjust method of taxation. To prevent this, write or telegraph immediately to your Congressman expressing your disapproval of this measure.

"I Told You So!"

WHEN the question of assessing tolls on vessels passing through the Panama Canal was under consideration by a Congressional committee the publisher of this magazine urged the members of the committee in the strongest terms possible not to assess tolls upon a net tonnage basis, but to use a more scientific method based upon the actual earning capacity of the vessels, and described as a "block displacement" method.

As matters now stand, Panama Canal tolls are assessed according to the net registered tonnage of the ship, and not according to the Panama Canal tonnage, which is measured by the earning capacity of the cargo-carrying space of the ship. The result is that ships that were brought in under the act of 1914, which permitted the entry under the United States registry of foreign purchased ships, are coming in under a less net registered

tonnage than they would have if the United States rules applied.

The net registered tonnage of a vessel bears no relation whatever to the earning capacity of the ship. The result is that certain cargo-carrying spaces in these ships are excluded in the tonnage measurements. In the case of the English shelter deck steamers, for instance, all cargoes carried on the shelter deck are excluded from the tonnage measurements, and as a result the English ships are getting an advantage in tolls at the canal.

The difference in the tolls which are actually collected at the Panama Canal under present registered tonnage conditions, according to statements recently made by Major-General Goethals, is about 30 percent less than it should be. A bill is now before Congress to have this condition modified, and, if so, the revenues of the Canal will far exceed the operating expenses, and it will soon be possible to pay part of the interest on the investment. It is not too late to remedy this folly, and immediate steps should be taken to bring this about.

1918 Naval Program

As the Naval Appropriation Act for the fiscal year 1917, recently approved by Congress, stands out beyond all precedent in the entire history of the United States Navy, careful consideration should be given to the continuation of this building policy during the following years.

In his annual report, the Secretary of the Navy points out that for the first time the policy of a continuing program for new construction has been adopted by Congress. In all its essential features the three-year program authorized on August 29, 1916, is that recommended originally to be executed in five years. The 813,000 tons of new construction authorized is greater than the total of the authorization of the ten preceding acts. The 377,000 tons to be begun as soon as possible is nearly five times the average of the preceding ten years. The total appropriation of $313,384,212 (£64,250,000) is more than twice as large as the amount carried by any previous appropriation bill. The execution of this program will give the navy the following vessels, completed and in commission in 1921: Battleships, first line, 27; battle cruisers, 6; battleships, second line, 25; armored cruisers, 9; scout cruisers, 13; cruisers, first class, 5; cruisers, second class, 3; cruisers, third class, 10; destroyers, 108; fleet submarines, 12; coast submarines, 130; monitors, 6; gunboats, 18; supply ships, 4; fuel ships, 15; transports, 5; tenders to torpedo vessels, 6; special types, 8; munition ships, 2. The foregoing numbers are based on the General Board's estimate of survival for the present vessels of the navy.

For the fiscal year 1918 the Secretary of the Navy recommends the construction of 42 vessels, as against 77 vessels recommended by the General Board. The vessels recommended by the Secretary are as follows: 3 battleships; 1 battle cruiser; 3 scout cruisers; 15 destroyers; 4 fleet submarines; 14 coast submarines; 1 fleet submarine tender; 1 destroyer tender. In contrast to this, the General Board recommends 4 battleships; 2 battle cruisers; 4 scouts; 20 destroyers; 9 fleet submarines; 18 coast submarines; 1 fuel ship; 1 transport; 1 destroyer tender; 1 fleet submarine tender; 1 gunboat; 12 mine sweepers; 1 supply ship and 2 seagoing tugs.

The Secretary of the Navy gives as his principal reason for recommending a smaller program than that of the General Board the lack of skilled labor and difficulty in promptly obtaining material, and he believes that the program which he has recommended is as large as can be constructed unless work on merchant ships is abandoned and the building ways thus employed are utilized for naval construction.

Although everyone is fully aware that the present facilities of both private and Government shipyards are taxed to their utmost capacity, and that the conditions of the labor and material markets are causing delays, nevertheless if the country were assured of a continuing program based more closely on the recommendations of the General Board, we have no doubt that these difficulties would be easily overcome. Neither shipbuilders nor steel makers, however, can be expected to be prepared to deal with haphazard spurts in naval construction.

Reinforced Concrete in Ship Construction

(Communicated)

In a recent issue of MARINE ENGINEERING I noticed an article regarding Norwegian concrete barges and a short comment by a naval engineer, who stated that although numerous barges of this kind had been built in this country and the Panama Canal Zone their use had not been an unqualified success, and that the possible advantages in cost would be more than counteracted by increased cost of propulsion due to the heavier weight of the vessel.

There is, without question, a great future ahead for reinforced concrete in ship construction. The first attempts have necessarily been crude and have therefore not always been entirely successful. However, we must not forget that all great inventions, especially in ship construction, have been the results of scientific development of ideas which often were introduced by laymen in a very crude form and were later, with the assistance of experienced marine engineers, transformed into the great successes of the present day.

I have made the building of concrete ships one of my life's problems and have carefully studied the scientific principles which must be adopted in order to insure success. Not only for the construction of smaller vessels as barges and scows is concrete an entirely suitable material, but also for large ocean-going ships will its use be perfectly safe and extremely advantageous.

The principal faults of all previous attempts of concrete ship construction have been that concrete builders tried to use everyday methods and means in design and mixing and applying the materials. Most of these vessels were built of ordinary concrete mixed and placed in the common way and the special requirements of ultimate service were not sufficiently taken into consideration. The designs were made without consultation with marine engineers and the strains which the empty and loaded ship had to resist under all the different and changing conditions were only more or less intelligently guessed at.

In spite of all this, however, satisfactory results have been obtained in most cases, and therefore the subject is worthy of careful consideration and encouragement, especially at these times when the production of freight ships is one of the greatest problems of all nations.

So far, two methods have been used for the construction of concrete barges:

The first method consists in building an inside and outside form for the ship's hull, and between these forms (which were separated to allow for intended wall thickness) the necessary reinforcement was placed. Then a concrete, composed of Portland cement, sand and crushed stone, or gravel, was poured in a semi-liquid condition to fill the forms and to encase the steel reinforcement. After the concrete had sufficiently hardened, the forms

were removed and the barge was finished by pouring bulkheads, division walls, and decks, etc., in similar manner.

This method resulted in extremely clumsy and heavy vessels which can only be used for sand and construction barges. The ship itself is unelastic, and in collision with wharfs and other vessels, etc., dangerous cracks develop which are difficult to repair and which will often result in loss of the entire ship.

The second method consists in using a light steel skeleton, placing over the outside of the same an expanded metal or wire fabric and finishing the hull by plastering over this sheathing a rich mortar coating in the same manner as light curtain and partition walls are formed in fireproof building construction.

This method is a great improvement over the first one but can only be used for smaller boats, launches, etc., and of course is practically out of question for freight barges.

I have invented and developed a series of entirely new methods of construction which allow the building of large and small concrete vessels of remarkable elasticity and of comparatively light weight. In addition to this the cost of construction is greatly reduced—no forms being used—and as all concrete is handled, applied and finished by machinery, especially designed for this purpose, the risk of poor workmanship is almost completely eliminated.

The ship's hull consists of a strong framework of steel which is so designed that the combined strength and advantages of steel and concrete are fully recognized. This truss frame is erected and riveted in the ordinary manner. In the completed ship the steel frame is entirely encased in concrete and thereby protected against rusting. By this encasing the steel members are also stiffened and the "buckling" stresses are greatly reduced. For this reason the steel members of the frame are of simple design and relatively light weight.

After the steel frame is completed, the same is covered with a "multiple unit" wall construction (of the writer's design) of varying thickness. The walls are formed of a high grade concrete applied by compressed air and each section is independently reinforced by networks of light steel bars and wire mesh. All ship shells, bulkheads and decks are formed in a similar manner without the presence of any construction or connection joints, so that the completed ship is one seamless, monolithic structure.

The concrete is composed of Portland cement and crushed quartz or other suitable stone material. All pieces not passing a one-half inch screen are rejected. These materials with the necessary waterproofing medium and the water for proper hydration are mixed and ground together and before being placed are properly conditioned to reduce the danger of cracking due to excessive expansion and contraction.

The material, so prepared, is applied in even and uniform layers by means of a powerful stream of compressed air with a special machine named the "Tector," especially designed for this purpose. For the material combination thus described, the name "Torcrete" has been adopted. It is really a waterproof concrete of highest possible quality.

After the last coat of "Torcrete" has been sufficiently hardened, the outer surfaces are rubbed down to an even, smooth finish with rotary compressed air-driven grinders, and the entire ship may be painted as usual.

These, of course, are only the general outlines of future cement, or rather "Torcrete," ship construction. These methods can also be advantageously employed for reconstruction and repair of old steel ships and for placing of bulkheads, tanks and decks in old hulls.

The principal advantages of the Torcrete ship are its low cost and the rapidity with which such vessels can be built. However, even at a considerably higher price, its use would be of greatest value for cargoes which require even temperatures and which are destructive to steel. For tank barges, ore and coal boats, refrigerator ships and similar vessels, the advantages of a non-rusting ship will be quickly recognized.

CARL WEBER,
President Cement-Gun Construction Company.
Chicago, Ill.

Rolling of Ships and Methods of Damping it

BY ARTHUR R. LIDDELL

The subject of the rolling of ships admits of more comprehensive treatment than it has hitherto received. Speaking generally, a stable ship careened in some way in still water, and, suddenly released, will roll in a certain period of her own. Should she when at sea encounter waves having the same period as her own or one that is a multiple of it, rolling increasing in amplitude will ensue. On closer examination, however, the problem is found to be less simple.

With increasing amplitude of rolling the period of the ship may alter to an appreciable extent. For small angles of inclination it is given by the formula

$$T = .554\sqrt{\frac{k^2}{m}}$$

in which T is the period for a single roll in seconds, k is the radius of gyration in feet, and m the metacentric height (GM) in feet. The more general formula, however, is

$$T = .554\sqrt{\frac{k^2}{l \sin \alpha}}$$

in which l is the righting lever in feet and α the angle of heel in degrees.

Where the curve of righting levers coincides up to the extreme angle of roll with the tangent to it drawn from the origin, the general formula will give good results. But the curve may rise above or fall below the tangent, and on the degree to which this takes place the correctness of the result will in each case depend. At the angle at which the deck edge becomes immersed a considerable drop in the curve begins to set in. When this happens, or when in a seaway, the top of a wave crest comes on deck, a new factor is introduced. The water lodges behind the bulwark, or, in the case of an open rail, is slow in running off. Experiment has shown the damping effect of such an immersion of the deck edge to be very considerable. When it occurs the period of the ship is at once lengthened, and this produces a difference between the phases of ship and waves, which, though small to begin with, increases with every succeeding roll. Especially when the ship has a bulwark, the rolling gradually subsides till the two sets of impulses at work act in opposite directions. The water runs off the deck and the process begins again.

It is said that the heaviest rolling often takes place in a confused sea. A confused sea is not always so irregular as it at first sight appears. It may, in fact, consist of trains of waves set up by two or more winds that have been blowing in different directions in succession. Consider the case of two such trains, the one of 400-foot waves and the other of 500-foot waves, at an angle of 45 degrees with it, the latter considerably degraded from the original height. A vessel may find herself obliged to steam slowly against the high waves and, in accordance with good practice, at an angle with them. She may thereby find herself broadside on to the degraded waves, and it may also happen that, say, the half period of these latter synchronizes with her own, whereas the period or half period of the high waves due to the gale actually blowing does not. Again, the degraded waves may be

running at right angles to the shorter waves and the synchronism be just right for the course which the ship would have to choose on either tack. Or again, there may be three trains of waves running and the ship find it impossible to avoid synchronism with one or other of them.

She has the greater freedom of action in the case of a single train of waves where a slight change of course may bring her considerable relief. A single train of waves may itself appear irregular in so much as a few waves of extra height periodically occur in it. Dr. Vaughan Cornish has shown this to be the result of a gale moving in the same direction as a long ocean swell. The origin of the ocean swell is not quite clear, but it is an observed fact that low swells of very long period traverse the ocean, and the storm waves ride over their crests and troughs, giving the irregular appearance referred to. Their effect on the rolling of a vessel may be either to increase or to diminish it at certain points in the train, according as the crests of the swell happen to coincide with crests or with troughs of the storm waves.

In regard to length of wave, there are two critical conditions for any given ship. The one is that in which the length of the wave is the same as her own, when its crest rises highest on her side, and the other is that in which the periods of ship and waves coincide, as referred to above. But it may happen that these conditions occur together, so that waves of the ship's own length have a period the same as her own. When this is so, the efforts of successive waves to careen such a ship traveling over them are the greatest, since each one then exerts its maximum possible impulse. To build and stow a ship in such a way that the two critical conditions cannot occur simultaneously is possible, but both of them will still have to be provided against.

To meet the case in which the length of the ship is the same as that of the waves a sufficiency of freeboard must be provided, and that not only at mid-length of the ship, but all fore and aft. To prevent violent rolling, the resistance to the rolling motion at different angles of heel may be made to vary. Bilge keels effect this when one of a pair of these emerges from the water at a certain angle of inclination.

The general effect of bilge keels is to increase the resistance of the ship to rolling. Their presence reduces the amplitude of successive increases of roll, so that with successions of impulses of given strength a ship takes considerably longer to reach a given angle. At the same time it increases the period by a percentage which, though not large in itself, may attain importance by a series of repetitions. If a pair of bilge keels be arranged in such a manner that they are alternately rolled out of the water before the deck edge is immersed, the amplitude of the end portion of each roll is increased and its period is at the same time shortened. Provided a number of rolls be still needed before immersion of the deck edge takes place, the acceleration may be sufficient to damp the rolling and make it gradually die down for a while.

Should the deck edge of a ship become immersed, perhaps so that water comes on board and is caught behind a bulwark, an effect contrary to that of the emersion of a bilge keel is produced. The period of the ship's roll is lengthened, and this more and more the deeper the immersion and the greater the weight of water on deck. The synchronism is gradually destroyed and the rolling motion again dies down, ceases for a time, perhaps, and then gradually begins again.

Side fins arranged a little above the water line have a greater damping effect than bilge keels, but objection is made to them on the grounds that they increase the breadth of the ship and that they interfere with boats that have to come alongside.

Another method of damping rolling is that of the water-chamber containing so-called loose water with perhaps some valve arrangement controlling the flow from side to side of the ship. This is stated to be effective when the stability of the ship is considerable. When the stability is small such tanks are seldom used, even when they form part of the equipment of a ship. They may, indeed, become a source of danger in giving a ship a list. They take up room and are expensive. This is true in a still higher degree of the Schlick gyroscope, which, however, is less likely to become dangerous.

Rolling may be damped by any of these devices, but not pitching, and, although they may make life pleasanter for passengers, they will not entirely prevent *mal de mer*. But the relief of *mal de mer* is not their only object. They also help to keep the deck dry. Whether raftlike motion would justify a reduction of freeboard, and if so, what reduction, are very debatable points, but with the present official freeboards, ships that possessed it would be subject to far fewer casualties than the average ones on service to-day.

There are two classes of ships in which heavy rolling cannot come in question. These are the very broad Dutch logger and the monster passenger liner with moderate stability. By reason of her large proportion of breadth to depth, the logger's period is extremely short. The wave critical to her in this relation is so short, and therefore small, that it has practically no effect on her lateral motion. She may pitch like other vessels, and in this way be uneasy enough.

The monster liner has an actually greater, but in relation to her dimensions, much smaller GM-height than an average vessel of medium size. Her period, as measured by the formula

$$T = .554\sqrt{\frac{k^2}{m}}$$

is a very long one. A wave of the same period would be longer than the very longest of those likely to be encountered. These monster ships pitch very little, on the one hand because the waves that might be long enough to affect them are relatively low, and on the other, because the proportions borne by their lengths to their other dimensions are very large ones. Moreover, the long waves are the ones most seldom met with.

For the smaller ships, which we shall always have with us, the problem of damping rolling still remains to be solved. In view of the objections to fixed side projections, some kind of removable fin might be applied. The mechanical difficulties of fitting such fins, fitted, say, in short pieces so that they could be drawn inboard like centerboards or folded up against the ship's side, do not seem insuperable. They would be expensive, but their potentialities might be very considerable. A beamy ship that could be kept from rolling otherwise than with the waves would have advantages that would justify a good deal of outlay of the kind contemplated. People on board would feel little lateral motion and the deck would be comparatively free from floodings. Cargo shifting would be unknown and sailors and firemen would work under ideal conditions. Then, again, the moment of resistance of a ship to longitudinal bending diminishes considerably when she is careened over, and if a non-rolling ship could not be let off with comparatively light scantling, she would at least keep the sea longer without need of repair.

The damping devices above referred to are not the only possibilities. Side tanks just above the waterline that would admit water readily through apertures and part with it slowly would increase the radius of gyration and perhaps raise the center of gravity of the ship when she rolled, thus increasing k^2 and reducing m in the formula,

and also lengthening the period. When the rolling ceased the water would run out again.

The prevention of rolling seems to offer a promising field for the inventor and one in which success may bring high reward. It may be observed that the rolling of certain warships was unintentionally damped by the fitting of the side armor plating so that it projected at its foot beyond the curved surface of the side. Reduction of rolling has also been claimed for a certain line of steamers, which, on account of wharf conditions were each fitted with two pairs of bulky fenders, viz., one pair at about deck height and the other some feet below it. In both these cases the good effect was produced by alteration of the period by means of side projections rolled into or out of the water. But, without the use of mechanical devices, much can be done in the fixing of the dimensions of a ship to avoid excessive rolling.

It is generally assumed that calculations of the vertical position of the center of gravity entail an enormous amount of work. This is perhaps true for a war vessel or where there are very many considerable weights the distribution of which may vary. But a large part of the hull of a plain merchant ship has its stereotyped position in every design. Boilers, engines, cables and such like larger parts of the whole can each be treated separately in the final calculation. In themselves these are either fairly regular constructions with known positions of center of gravity or they can be represented by plain figures easily dealt with. Small weights can either be grouped or neglected. The possible percentage of effect on the whole must in each case be kept in view.

Of more importance and sometimes a matter of great difficulty is the cargo. A homogeneous cargo filling the holds may be taken account of with relative ease as a whole. When heavy cargoes are in heaps in the different holds the figure and position of each heap must be known. A table of the centers of gravity and moments of inertia of a variety of plain solids will here be found useful. In the case of general cargo a knowledge of the habits of stevedores and of the possibilities of discharge of goods and taking in of others at intermediate ports on a voyage becomes necessary.

Throughout the calculations it is necessary to think in terms of percentages of moment of inertia or the equivalents of these. Exact results will never be attained, but something less than exactness will suffice. If the result be, say, 4 percent out, the period is altered by only $\sqrt{4}$ percent. But a difference of 2 percent on the period counts for very little in considering the tendency of a ship to roll heavily, although it may be important when waves of a given period are in question. If rolling be set up by mechanical means in still water, the period thereby measured may, when the moment of inertia or the radius of gyration is known, be used to determine the GM-height or m. The general equation

$$T = .554\sqrt{\frac{k^2}{m}}$$

may be written in the form

$$m = .307\left(\frac{k}{T}\right)^2$$

Some attention has recently been given to the question of determining a merchant vessel's stability before she leaves port. In theory this may be done by the aid of the last-mentioned equation, provided an approximate estimate of her radius of gyration has been made and her period can be determined by causing her to roll. Unfortunately, no sufficiently convenient means of careening and releasing her again is available. The expedient of men running from side to side on deck can seldom be applied, and if a mechanical device were invented the ship could still not always be released from her moorings to apply it.

Methods have been elaborated for measuring a ship's period while she is rolling at sea and determining her most advantageous GM-height therefrom. If the necessary observations be conscientiously carried out this may give important results. It will indicate to the men who work the ship the stowage of different cargoes and enable them to make more definite reports than has hitherto been possible of the prevailing conditions, so that in the design of later vessels for a given service better advantage may be taken of their experience.

Until a satisfactory method of preventing it has been discovered and applied, rolling may, under given conditions of the sea, be expected to occur in the case of every ship of ordinary size and design. Excessive rolling resulting from excessive stability may be avoided, first, by attention to lessons of experience entailing a not very formidable calculation of the designs of vessels, and second, by reasonable stowage. The practice of some stevedores of taking the cargo as it comes and disclaiming responsibility for consequences must be confined within the limits which a better understanding of cause and effect will some day enable us to define.

Increased Duties of the Steamboat Inspection Service

The urgent need of an increased force of inspectors in the United States Steamboat Inspection Service is emphasized in the annual report of the supervising inspector-general of this service. In the estimates for the fiscal year ending June 30, 1917, Congress provided for thirty-one additional inspectors. This increase of force was most urgently needed, in order that the inspectors could properly perform the duties that are required of them. The time had come when it was useless for Congress to pass any more laws referring to safety on board ship or for the Board of Supervising Inspectors to make further regulations in regard to the subject until a sufficiently large number of men was furnished to enforce the provisions of the laws and the rules and regulations that already existed. Large as the increase was in the number of inspectors, a sufficient number has not yet been furnished, and it is necessary that a material increase be made in the number of inspectors in the near future, in order satisfactorily to carry on the work of the service.

The work of the service has increased immensely as a result of admittance to American registry of many foreign-built ships, and as the time approaches when these vessels will be subject to the same inspection as American-built ships, it can be appreciated that with the large number of large vessels that have been admitted to American registry the inspectors of this service on the coasts will be most busily occupied in examining these vessels preparatory to the issuance of certificates of inspection.

The supervising inspector general also calls attention to the need of a scientific and careful revision of the laws that relate to shipping. This revision, however, should be undertaken only by persons thoroughly familiar with the conditions. For a person to attempt to revise the laws that relate to shipping in a period of one or two months is, on its face, absurd, and for one person to undertake it is the height of absurdity. As to why the officers responsible for the enforcement of the law have not undertaken a revision of the laws long ago, the supervising inspector general states that the answer to that question can be found in the fact that the duties of these officers are so arduous that they have simply not had the time to undertake such a task.

UNITED STATES SUPERDREADNOUGHT PENNSYLVANIA

Built by the Newport News Shipbuilding & Dry Dock Company

(Copyright, H. Muller, Jr., New York)

U. S. S. *Pennsylvania* Steaming Up East River to Navy Yard, New York.

The *Pennsylvania* went into commission on June 12, 1916. She has a normal displacement of 31,400 tons and an overall length of 625 feet. On trial she averaged a speed of 21.05 knots. Propulsion is by four screws actuated by Curtis turbines. The main armament consists of twelve 14-inch guns arranged in four turrets.

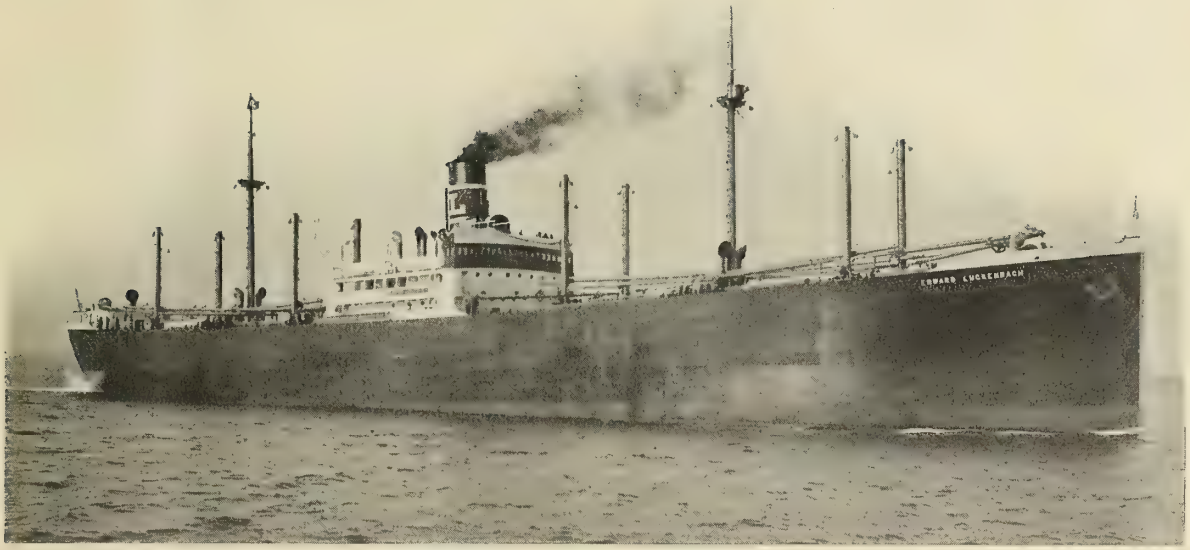


Fig. 1.—S. S. *Edward Luckenbach*

Freight Steamer Edward Luckenbach

First of Five Sister Ships Building at Fore River Shipyard for Luckenbach Steamship Company—Propulsion by Geared Turbines

A NOTABLE addition to the fast growing mercantile fleet of the United States has recently been made in the delivery of the freight steamer *Edward Luckenbach*. This vessel, the first of five now under construction for the Luckenbach Steamship Company, of New York and San Francisco, by the Fore River Shipbuilding Corporation, of Quincy, Mass., represents the highest type of general freight vessel and in its design and construction reflects credit on both builders and owners. For the following details we are indebted to Mr. E. C. Bennett, naval architect of the Fore River Shipbuilding Corporation.

The *Edward Luckenbach* was designed to the owners' special requirements for coast-to-coast and overseas trade, and in the adoption of a modified cruiser stern a novel arrangement of bridge and deck house bulwarks, with two masts and eight king posts and one large smokestack, inaugurates for the Luckenbach Steamship Company a handsome vessel of individuality and distinctive appearance.

As will be seen from the accompanying plans and photographs, this vessel is of the shelter deck type with large cargo hatches, wide-spaced hold stanchions, wide-spaced frames and no side stringers. She has been constructed under the special survey and to meet the full requirements for hull, equipment and machinery for both the American Bureau of Shipping and Lloyds Register of

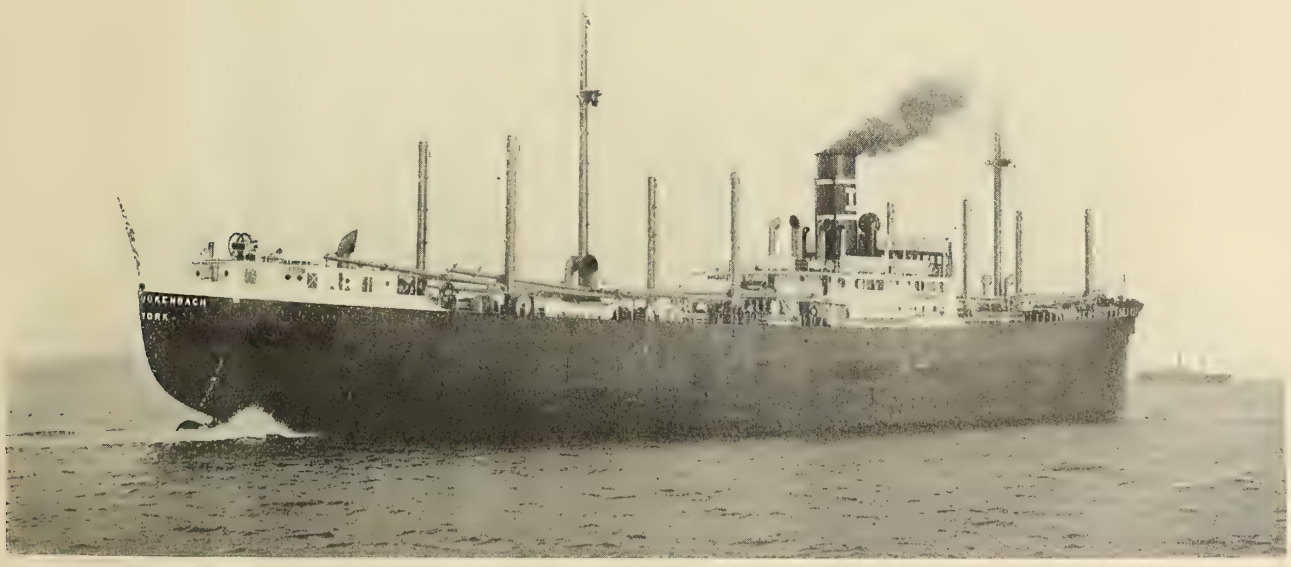


Fig. 2.—View of the *Edward Luckenbach* Showing Cruiser Stern

GEARED-TURBINE FREIGHT STEAMER EDWARD LUCKENBACH

Built by Fore River Shipbuilding Corporation

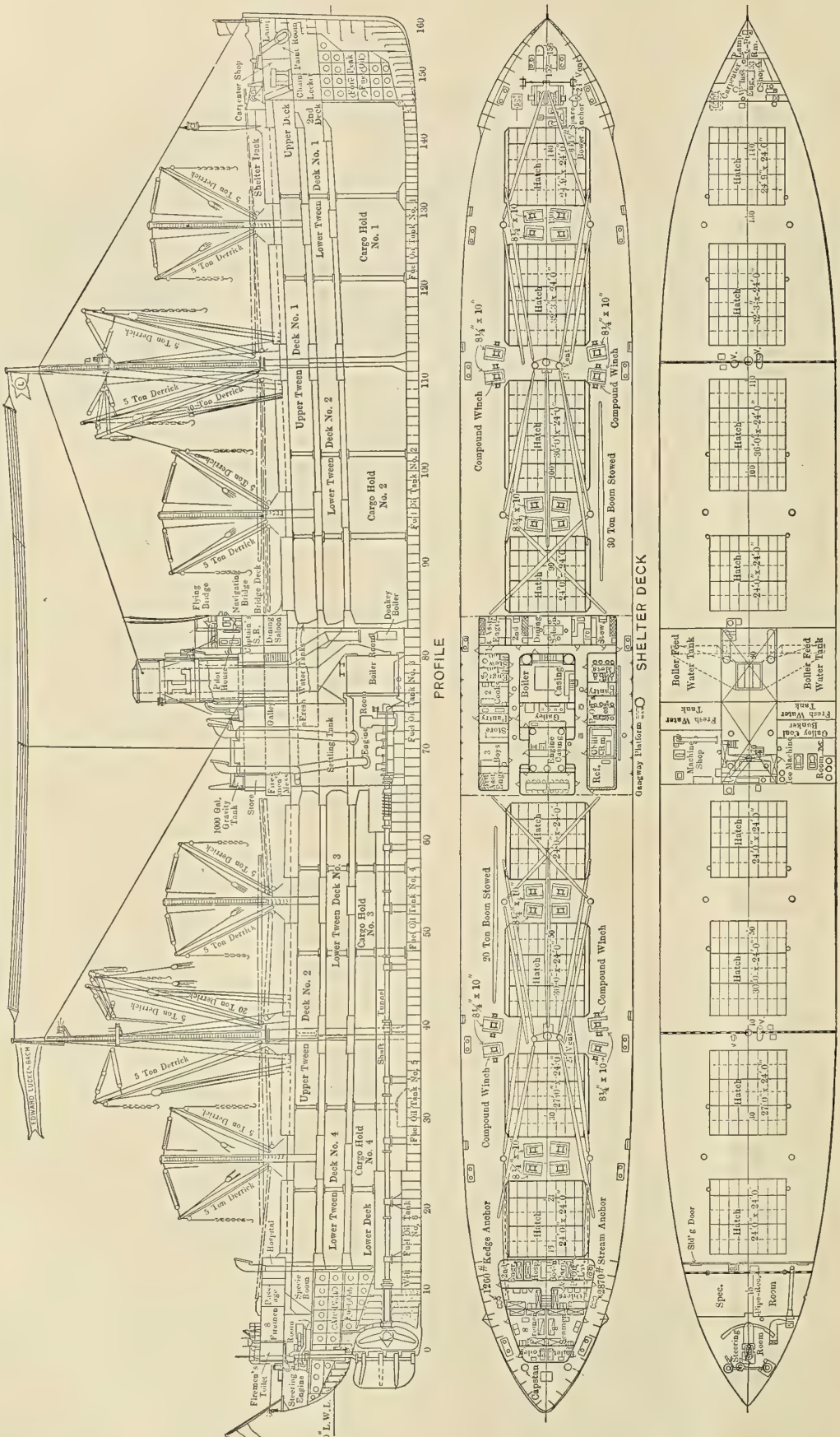


Fig. 3.—Profile and Deck Plans

FREIGHT STEAMER EDWARD LUCKENBACH

Built by Fore River Shipbuilding Corporation

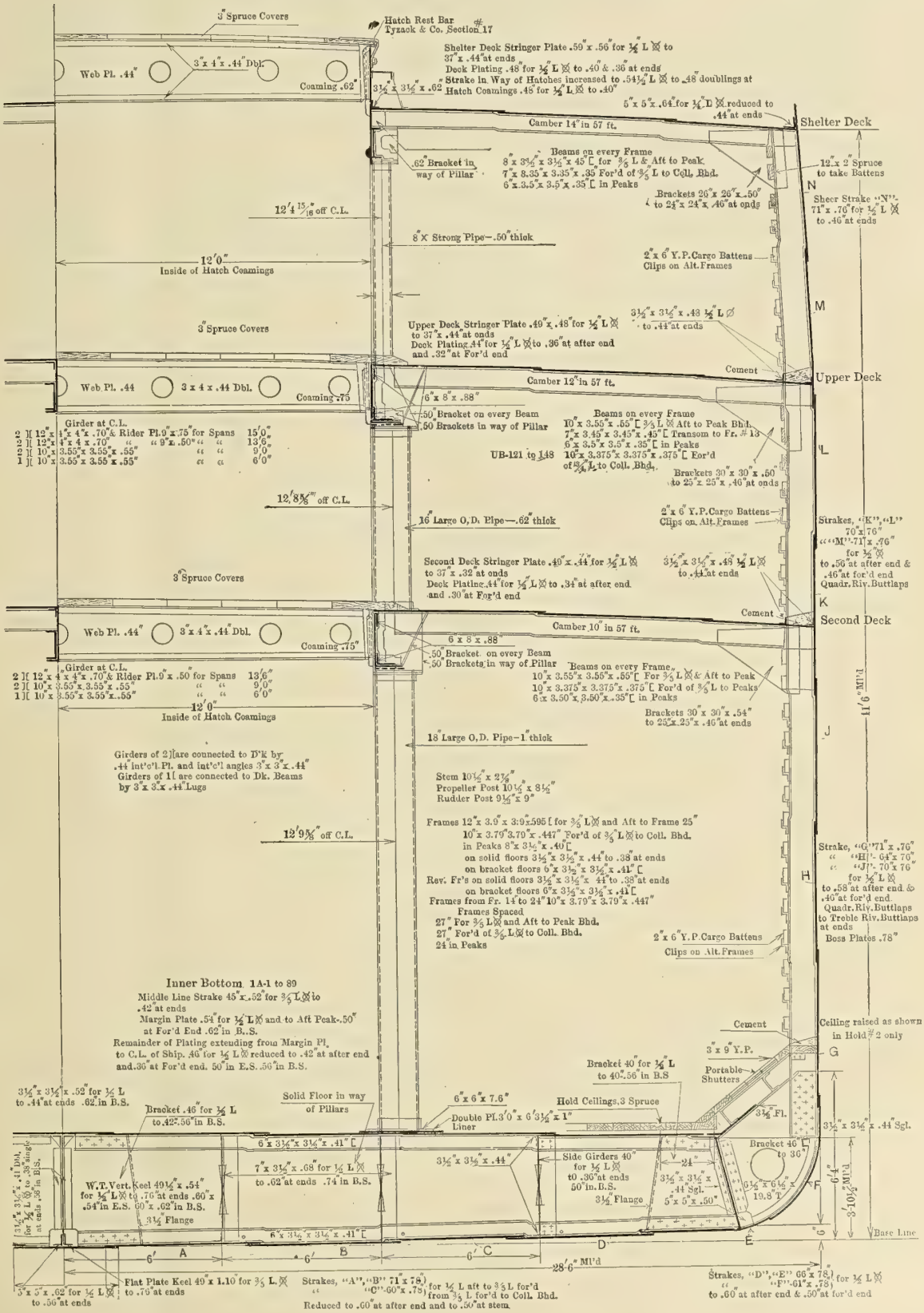
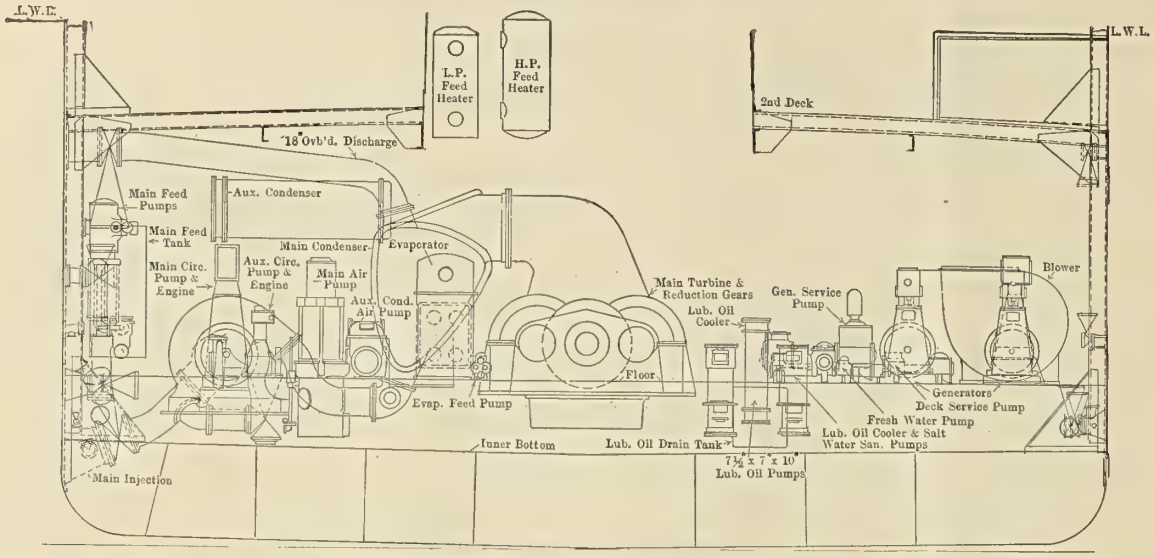


Fig. 4.—Midship Section, Showing Scantlings

FREIGHT STEAMER EDWARD LUCKENBACH

Built by Fore River Shipbuilding Corporation



CROSS SECTION FRAME NO. 66 LOOKING FOR'D.

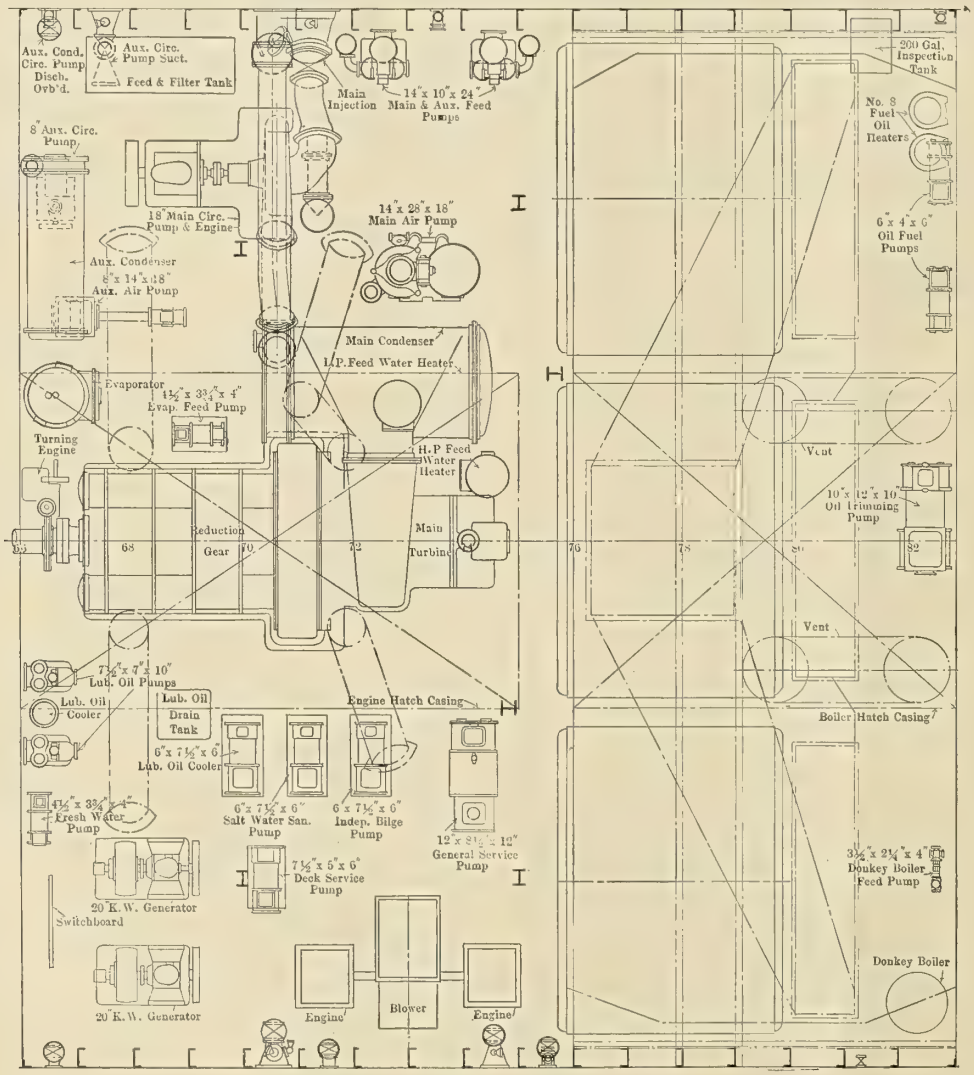


Fig. 5.—Machinery Arrangement

Shipping, to obtain the highest classification ratings with freeboard assignment, in the records of both societies.

The *Edward Luckenbach* is of the following dimensions:

Length overall	456 feet 5 inches
Length from forward side of stem to after side of rudder post	437 feet 6 inches
Breadth molded	57 feet
Depth molded to shelter deck at side	41 feet 6 inches
Gross tonnage	8,151
Net tonnage	6,141
Panama Canal gross tonnage	8,543
Panama Canal net tonnage	6,426
Load draft	31 feet 8 inches
Deadweight, tons	12,250
Height between shelter and upper decks	9 feet 6 inches
Height between upper and second decks	9 feet
Fuel oil capacity, tons	2,131
Capacity of cargo holds, cubic feet	584,270

There are three continuous steel decks running the full length of vessel, named shelter, upper and second, respectively. The second deck beams are in excess of the classification societies' requirements, and with a 'tween deck height of 9 feet 6 inches this vessel readily adapts itself for use as a transport or for carrying cattle.

The double bottoms are constructed on the alternating solid and bracketed floor principle, and with the forward and after peak tanks are arranged for the stowage of fuel oil. The fuel oil settling tanks and the fresh and boiler feed water tanks are located in the 'tween deck spaces outboard of the machinery casings.

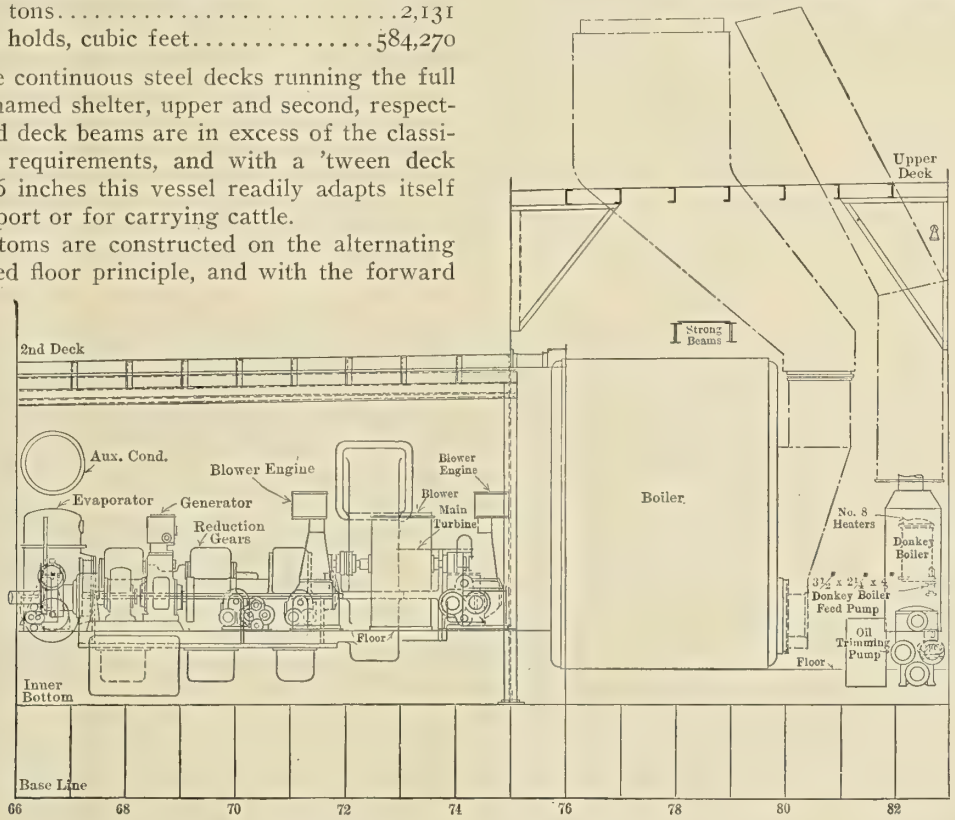


Fig. 6.—Longitudinal Section Through Machinery Space

The arrangement of masts, king posts and deck winches has been made with a view to the rapid handling of general freight. The foremast has one 30-ton and four 5-ton booms, the mainmast one 20-ton and four 5-ton booms, and each of the eight king posts has two 5-ton booms. The deck winches, constructed by the Hyde Windlass Company to the special requirements of the owners, are twenty-four in number, twenty being single-geared and four compound-geared, all with cylinders 8¼ by 10 inches.

The steering machinery, also furnished by the Hyde Windlass Company, is of the Brown steam tiller type with cylinders 9 inches by 12 inches, and operated by telemotor from the pilot house and flying bridge and by shafting from double wheel hand gear stand on top of after deck house.

The windlass and after warping capstan were supplied by the American Engineering Company, the former being of the worm drive type, having the windlass on shelter deck and a double 14-inch by 12-inch cylinder inverted engine on deck below. It is the No. 12 size and arranged to take 2⅜-inch stud link chain. The warping capstan engine, having 8-inch by 10-inch double cylinders, is located in the steering engine room and operates two 19-inch diameter gypsy heads on the shelter deck.

Special attention has been given to the ventilation of cargo holds, each hold and 'tween deck cargo space having a natural supply of air through cowl ventilators and a mechanical exhaust by four Sturtevant electric driven exhaust fans, each having a rated capacity of 6,000 cubic feet of air per minute. These fans are located in the fore peak boiler room, engine room and steering engine room and exhaust to the atmosphere.

In view of the long voyages the *Edward Luckenbach* will travel, the comfort and habitability of the officers' and crew's quarters were given special consideration by the owners. The navigating bridge is entirely enclosed, thus insuring comfort to the officers on watch in all weathers. The interior of this enclosed bridge, together with the dining saloon, captain's suite, and owner's stateroom, are attractively paneled in white enamel and mahoganized birch. The rooms for the senior and junior officers are commodious and well arranged. Each is furnished with ample locker and drawer space and with upholstered settees. The crew and firemen are berthed in the after deck house in large rooms, and they also are well equipped with individual metal lockers and drawers below the berths.

The propelling machinery is located amidships and consists of a Curtis turbine driving the propeller shaft through a double reduction gear at a designed normal speed to deliver 4,000 shaft horsepower at 90 revolutions of the propeller shaft. The turbine is fitted with overload nozzles, so that the machinery will develop 4,500 shaft

TABLE 1—ENGINE ROOM

PERIOD.	PRESSURES, LBS. GAGE.			VACUUM.	BEARINGS.		TEMPERATURE, DEGREES F.		
	Main Steam.	Steam Chest.	Oil.		Forward.	Aft.	Injection.	Discharge.	Room.
12:00 to 12:30	176.8	137.3	8.8	28.75	103.5	85.5	44.	69.	74.
12:30 to 1:30	179.4	159.3	12.0	28.75	103.3	98.	45.	64.7	75.
1:30 to 2:30	191.0	176.1	17.0	28.75	103.0	117.7	45.	66.3	79.
2:30 to 3:00	194.0	179.0	17.0	28.90	102.0	116.5	43.5	65.0	78.5
Overload	195.0	170.0	28.75						

TABLE 2—FIRE ROOM

PERIOD.	PRESSURES, LBS. GAGE.			FUEL OIL AT BURNERS.	TEMPERATURES, DEGREES F.			AIR PRESS, INCHES.
	MAIN STEAM AT BOILERS.				FUEL OIL HEATER.			
	Starboard.	Center.	Port.		Inlet.	Outlet.	Room.	
12:00 to 12:30	185.5	182.8	183.5	121.7	103.7	247.8 248.2	96.7	.9
12:30 to 1:30	182.1	179.3	179.9	146.4	104.6	28.2	92.9	.87
1:30 to 2:30	192.4	189.2	189.4	165.7	99.3	253.6	88.9	.93
2:30 to 3:00	196.	192.5	192.5	158.8	97.5	254.0	86.0	.98

TABLE 3—TRIAL TRIP DATA

TIME.	REVOLUTIONS.			S. H. P.		FUEL OIL.			WATER TURB. ONLY.	
	Counter Reading.	Period.	R. P. M. Period.	T. Meter. Read. 4834	Period.	Meter Read.	Lb. Per Hr.	Lbs. Per S. H. P.	Lbs. Per Hr. Period.	Wate Rate Period.
12:00	125,436	....	....	70	....	900	....	....	....	....
12:10	126,282	846	84.6	78	3,190	967	....	....	....	....
12:20	127,135	853	85.3	76	3,140	1,075	....	....	....	....
12:30	127,999	864	86.4	81.5	3,400	1,114	....	....	....	....
Average.....			85.4		3,265		3,200	980	39,700	12.17
12:40	128,876	877	87.7	85.0	3,600	1,178	....	....	....	....
12:50	129,764	888	88.8	85.5	3,670	1,268	....	....	....	....
1:00	130,658	894	89.4	89.5	3,865	1,362	....	....	....	....
1:10	131,547	889	88.9	86.5	3,715	1,422	....	....	....	....
1:20	132,440	893	89.3	88.5	3,820	1,522	....	....	....	....
1:30	133,346	906	90.6	89.5	3,920	1,610	....	....	....	....
Average.....	....	..	89.1	....	3,787	....	3,710	980	42,600	11.24
1:40	134,261	915	91.5	90.0	3,980	1,715	....	....	....	....
1:50	135,189	928	92.8	94.0	4,210	1,812	....	....	....	....
2:00	136,122	933	93.3	94.0	4,235	1,902	....	....	....	....
2:10	137,055	933	93.3	95.0	4,280	1,986	....	....	....	....
2:20	137,986	931	93.1	94.0	4,230	2,065	....	....	....	....
2:30	138,916	930	93.0	92.5	4,150	2,173	....	....	....	....
Average....			92.8		4,181		4,210	1,007	46,650	11.17
MEASURING WATER FOR ALL PURPOSES										
2:30	138,916	....	....	....	....	2,173	....	....	....	....
2:40	139,844	928	92.8	96	4,300	2,254	....	..	....	....
2:50	140,773	929	92.9	96	4,310	2,352	....	....	....	....
3:00	141,702	929	92.9	97	4,350	2,450	....	....	....	....
Average....			92.9		4,320		4,140	960	54,800	12.67
Overload....			98	110.5	5,230	With 2 overload nozzle valves open.				

Draft = 10′ 4½″ forward, 18′ 9″ aft.
Speed by log 14 knots.
Fuel oil 18,170 B. T. U. per lb.
0.894 Sp. Gr. at 60° F.
Displacement = 7,300 tons.

horsepower with a propeller speed of 93 revolutions per minute. The turbine is designed to operate with a steam pressure of 190 pounds in the steam chest and against a vacuum of 28½ inches, with the astern turbine capable of delivering to the shaft about 50 percent of the power of the ahead turbine. The rotor is so arranged that the ahead and reverse wheels are carried on one shaft and operate in the same casing, the main exhaust being common to the ahead and reverse. The turbine is very substantially built of high grade steel, the blading being of Monel metal of heavy proportions, and the revolving element is designed so that it can easily stand an over-speed of 20 percent above the full speed revolutions.

The total reduction of speed between the turbine and propeller shaft is 37 to 1. The reduction is taken in two steps, the system employed being what is known as the double-drive type—that is, the pinion connected with the turbine engages with two gears, one diametrically opposite the other, thereby eliminating pressure on the pinion bearings and insuring perfect tooth contact between the pinion and the wheels. Each of the two wheels is coupled to a pinion, which in turn drive the main gear coupled to the propeller shaft. The high speed pinion is directly connected to the turbine shaft by means of a flexible coupling so arranged that any motion in the gears or pinions will not be transmitted to the turbine shafts.

The gears are double helical and are arranged in one plane, so that bearings and wheels can be easily exam-

ined and all parts readily kept in alinement. The turbines and gears were built by the General Electric Company, the gears being of the laminated type manufactured under the Alquist patents.

The propeller is 19 feet in diameter, with the blades set at a pitch of 16 feet. The pitch, however, is adjustable from 15 feet to 17 feet. The propeller blades are of manganese bronze and the hub of cast iron fitted to the propeller shaft with a taper key and held by a forged steel nut.

Steam is supplied by three Scotch boilers, each 16 feet 6 inches inside diameter, and 12 feet 3 inches long over the heads, with a heating surface of 3,546 square feet, each boiler having four Morison corrugated furnaces, 42 inches inside diameter. The boilers are designed for a pressure of 195 pounds per square inch and work under the heated system of forced draft, for which one Sturtevant multivane blower fan with two engines is located in the engine room. The boilers are arranged to burn fuel oil on the Dahl system, the necessary pumps, filters, heaters, etc., being arranged in the fireroom.

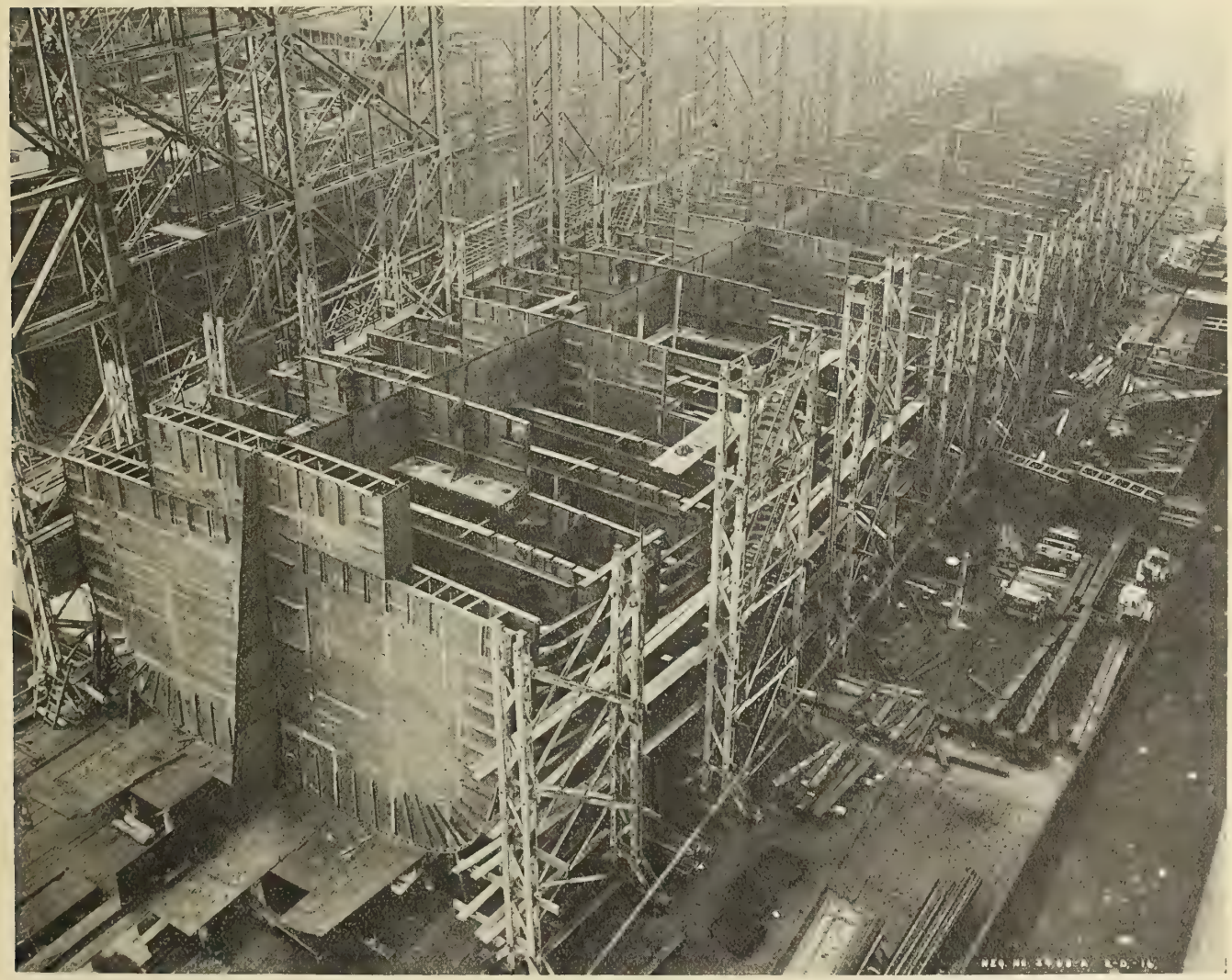
The main condenser of special construction for turbine work is placed on the port side of the engine, having a cooling surface of 5,850 square feet. The air pump, furnished by Blake & Knowles, is one of the independent wet and dry twinplex beam type, the necessary cooling water being supplied by the main centrifugal pump, having an 18-inch suction and discharge and driven by a 10-inch by 9-inch single cylinder vertical engine of the enclosed type and supplied with forced lubrication.

The necessary pumps, which are of the Blake & Knowles type, the high and low feed water heaters of Griscom-Spencer make, and an auxiliary condenser are located conveniently in the engine room. Abaft of the reduction gear is the thrust bearing, consisting of ten horseshoes with ample wearing surface. The line shafting consists of seven sections with the necessary bearings.

Fig. 5 shows the general arrangement of machinery in the ship, and it will be noted that the turbine and reduction gear type of engine leaves ample room for handling.

The electric plant consists of two 20-kilowatt General Electric generator sets driven by reciprocating engines. There is a 2-ton Brunswick refrigerating machine and a Griscom-Spencer evaporating machine of 35 tons capacity.

The *Edward Luckenbach* was taken on trial on November 28, the ship being in light condition, with measuring tanks and pumps installed so that the water measured by the main turbines alone, and the turbines and auxiliaries combined could be carefully ascertained. A torsion meter was fitted on the propeller shaft, the shaft having been calibrated together with the torsion meter before being installed on board. The oil used on the trial was heavy Mexican, which on test showed only 18,170 B. T. U.'s.



Record Work in Ship Erection

Contract 173 at yards of New York Shipbuilding Company, Camden, N. J. Keel laid November 1, 1916. 1,475 tons erected on December 1, 1916.

The whole of the machinery operated very satisfactorily, and after anchoring at Boston harbor for a couple of hours the vessel proceeded to New York, the trip from Boston to New York occupying about twenty-two hours.

The accompanying tables give data taken on the trial trip. The results are considered very satisfactory, as, at the normal designed rate of operating, the water rate of the turbines was only 11.2 pounds per shaft horsepower and the water rate of the turbines and auxiliary machinery was but 12.67 pounds per shaft horsepower of the main engines. The tables giving engine room, fire room and trial trip data will be found on page 12.

Motor House-Boat Vagabondia

Shallow Draft, Tunnel Stern House-Boat Designed by Cox & Stevens for Pittsburg Millionaire

THE motor house-boat *Vagabondia*, designed by Cox & Stevens, naval architects, New York, for Mr. W. L. Mellon, of Pittsburg, Pa., and built by the Gas Engine & Power Company and Chas. L. Seabury & Company, Cons., of Morris Heights, N. Y., was completed early in October and is now in the South making ready to receive Mr. Mellon and his guests, who will spend the winter on the vessel. *Vagabondia* is the second vessel of the same name which Mr. Mellon has owned, and the general arrangement of the new boat has been carefully developed as a result of the owner's experience with the older vessel in Florida waters.

The dimensions of *Vagabondia* are:

Length over all	130 feet
Beam	23 feet 6 inches
Draft	3 feet 0 inches

In type, this vessel is similar to Southern river steamers designed to run in extremely shallow water, the tunnel construction being used aft to give clearance for the propellers, which is made necessary by the extremely shallow draft.

The hull proper of the boat is not used for living quarters except a small portion forward, where a few of the crew are housed, the balance of the hull, outside of the machinery space, being used for water tanks and storerooms.

A very unusual feature of the boat is the fact that the main deck, on which the owner's accommodations are generally placed, is in this boat really a working deck, being given up to the necessary quarters for the crew, and there being on this deck a large amount of deck space for stowage and handling of a large number of small fishing and ducking boats with their accompanying gear.

The upper deck, which extends from stem to stern, is the owner's living deck, and on it are placed all the accommodations for himself and guests. As will be seen from the photographs, *Vagabondia* presents a pleasing and workmanlike appearance, and an inspection of her plans shows that she has every quality necessary for comfort in the waters where she will be used, all the rooms being large, airy and comfortably furnished.

The hull of *Vagabondia* is of wood, and, although the draft is unusually light, the hull itself is constructed heavily in order to take care of the frequent grounding which a vessel of this sort must contend with. In order to secure the necesary rigidity of hull, not only are the wooden scantlings very heavy, but considerable galvanized steel has been worked into the construction to give added stiffness.

The main deck beams are of galvanized steel, and a galvanized steel shear strake and deck stringer is worked at the main deck connected by galvanized steel brackets to the deck beams. In addition, on each side of the centerline at about one-half beam there is, fore and aft, a steel truss of lattice girder construction running the full length of the vessel, built up of galvanized steel angle bars and plates, which girders practically convert the hull of the vessel into a strong and rigid beam.

The machinery consists of two 150-horsepower, 6-cylinder Winton motors placed practically amidships. The gasoline (petrol) is carried on the main deck aft in a

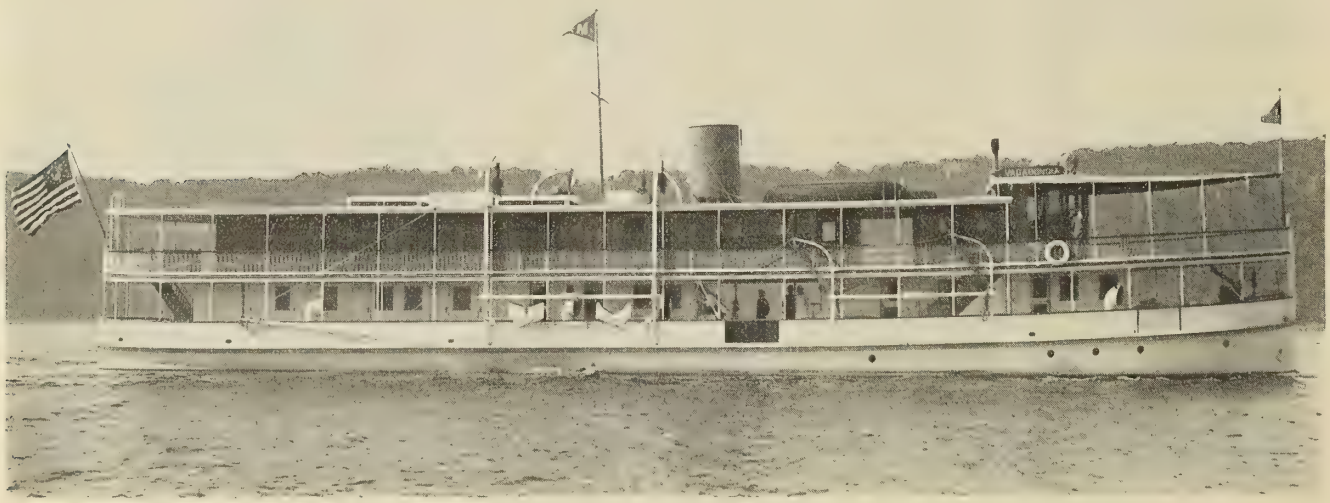


Fig. 1.—House-Boat *Vagabondia*, Propelled by Two 150-Horsepower Winton Six-Cylinder Engines

MOTOR HOUSE-BOAT VAGABONDIA

Designed by Cox & Stevens, New York

Fig. 2.—Living Room and Hall

Fig. 3.—Dining Room

Fig. 4.—Bath Room

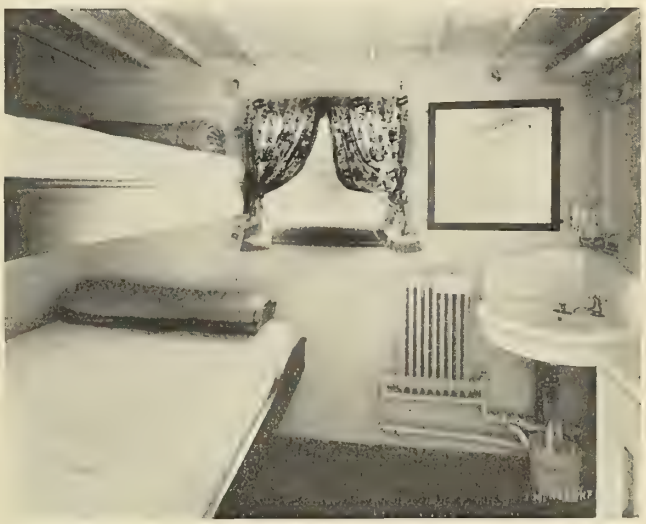


Fig. 5.—Guests' Stateroom

Fig. 6.—Galley

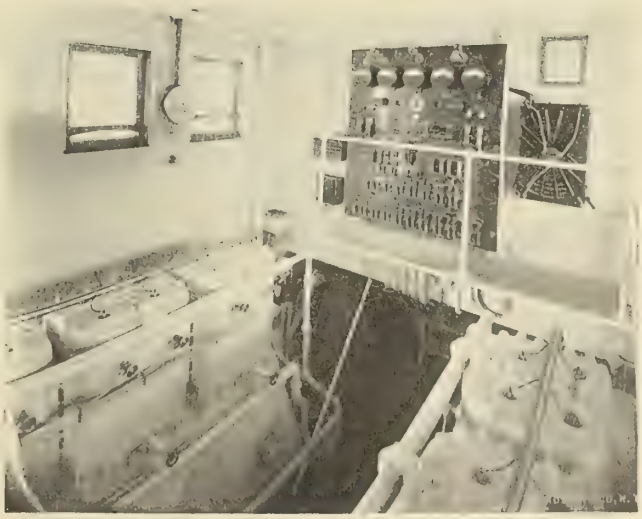


Fig. 7.—Engine Room

heavily constructed steel tank of 2,500 gallons capacity. Utmost care has been taken in connection with the gasoline (petrol) supply so that the danger from fire is practically eliminated.

The water tanks, of which there are four of 6,000 gallons capacity, are placed in the hold forward of the machinery space. Aft of the machinery space in the hold on the port side is a large fish well where bait and fish may be kept alive.

On the main deck are two deck houses, the forward one containing the mess room, in which is placed a hot-water heating boiler, and forward of this the galley and a room for dry stores. At the after end of this house is a large refrigerator with 7,000 pounds capacity, and at the forward end of the house another refrigerator for carrying fish.

The after house, which contains at the forward end entrance to the engine room, also contains a large storeroom for ship's stores, a pantry, a shower bath and bathing suit room, a drying room, captain's room, engineer's room, four other staterooms for officers, fishing guides, etc., and the necessary toilet rooms.

On the upper deck, which, as already stated, is the owner's living deck, there are also two houses. The forward house comains at the after end a smoking room, forward of which is a pilot house, from which the vessel is navigated.

The after house contains at the forward end a large living room and dining room combined, from which a central hall runs through this house, at the after end of which is a sitting room opening on the after deck. On the port side of this passage are three very large owner's rooms and one bath room, while on the starboard side are two other guests' rooms and additional bath room; also a pantry with large refrigerator and a room for stowing clothes.

The houses on the main deck are painted white, while those on the upper deck are of mahogany varnished. The general scheme of finish in the interior of the owner's and guests' quarters is simple paneling painted white, the furniture being of hard wood of a soft, brown tint. The upholstery and general furnishings have been carefully selected and the interior effect is very pleasing, as well as comfortable.

Vagabondia has a very complete outfit of auxiliaries, including large dynamos, ample storage battery capacity, electric windlass, air compressors, bilge, fire pumps, etc.

On trial, *Vagabondia* made better than 10 miles an hour, and she was found to handle in a very satisfactory manner.

Military and Technical Considerations of Battleship Design*

Large Battleships Advocated—Minimum Dimensions: Length, 640 Feet; Beam, 96 Feet; Draft, 30 Feet; Approximate Displacement, 36,000 Tons

BY NAVAL CONSTRUCTOR R. D. GATEWOOD, U. S. N.

THE whole history of warship design has been a long series of steps toward increased displacement, and, except for our own battleships *Idaho* and *Mississippi* and one or two classic examples abroad, there have been thus far practically no backward steps. Always an inevitable law of growth has asserted itself, and each successive vessel of every class has been larger than its predecessors.

In the case of battleships the tendency toward greater displacement would have been even greater were it not for two very important and practical objections:

1. The extreme reluctancy on the part of governments to spend such large and always increasing sums on single units of power.

2. The great difficulties in providing docking and harbor accommodations for vessels of the giant size demanded by those responsible for using these vessels in battle.

Means have been devised, as, doubtless, means will continue to be devised, to overcome these objections, but is there not a limit to this increase in dimensions? If so, what are the governing considerations that are likely to determine this limit? What are the minimum dimensions of the ship that will best meet our needs?

These dimensions are influenced and determined by four factors:

1. Our national policies. 2. Considerations of strategy and tactics. 3. Techincal limitations. 4. Cost.

Let us cast aside all preconceived ideas as to size and analyze with an open mind the influences of each of these governing factors on the military and technical characteristics of battleship design. From the facts developed by this analysis, let us then try to arrive at our minimum dimensions, bearing in mind always that the design thus determined merely gives "expression to the technical ideas and intentions of the epoch."

Policy and Ship Design

Fundamental questions affecting a state's welfare, comfort, and sometimes its very existence—questions that are the living embodiment of the will of its people—are called its policies. We have gradually accumulated a set of policies giving us contact with many other states along virtual frontiers approached in extent by those of England alone. By virtue of certain geographical, racial and economical conditions over which we have no appreciable control, these policies now conflict, and will continue to conflict, with the vital interests of various other world states. In the analysis of the relative seriousness of these conflicts the statesman should reason out which state is likely to be our most probable opponent, and then should adopt a definite naval building programme against that state. Our Congress has never done this, and yet the development of our fleet, if it is to uphold these policies, must be absolutely linked up with them.

Lacking a well-defined foreign policy, it was not until some time after the advent of the new steel navy that the United States made any material progress in the design of new types. At first, due to this lack of a definite policy to direct our efforts, we took one or two backward steps.

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1916.

As a natural consequence of "political drifting," we proceeded to copy foreign designs—designs embodying definite policies of foreign nations. Our needs could hardly have been expected to be met by following the policies of these nations, and there resulted several misfits. More are bound to result unless we are guided in the design of our battleships by a definite and sound foreign policy, and in the future, as in the past, we are certain to develop units, and even whole classes, that may be excellent specimens of naval architecture, but that are entirely unsuited to the needs of the country.

Strategy, Tactics and Design

Besides recommending a building programme providing for the number of battleships to be constructed each year, the General Board defines the military characteristics of our battleships, namely, the size and arrangement of battery, extent of protection, speed and radius of action, indicating the relative importance of the various main features. This definition of military characteristics is reached after having compared our national policies with those of other states as to the most probable sources of conflict, and after having considered the numbers and types of battleships of our most probable opponents. In arriving at these decisions the most valuable aids are the data derived from the analysis of the strategical problems and tactical studies of the war game worked out either by the game board of the War College or by the movements of actual ships of the fleet simulating a naval engagement. These studies have shown conclusively that—

Under modern conditions the gun is the principal weapon of the battleship, and concentration of superior gun fire at the decisive point at the critical time is always the key to victory.

With equal units, naval gun power can be assumed to vary as the square of the number of guns that can be brought to bear.

The mere possession of a greater number of units is useless unless this superiority in number can be employed in a concentrated way at the proper time.

There should be no reserves in a naval battle.

"The entire force should be brought into action as nearly simultaneously as possible, so distributed as to afford mutual support, and if practicable in such manner as to isolate a part of the enemy from the battle while the remainder is being defeated."

Reasoning from the above premises, it is obvious that concentration of armament constitutes an overwhelming advantage, and is in fact an absolute necessity. The great length of battle line and the great difficulties in maneuvering due to the number of units in the present-day fleet imperatively demand that, from the point of view of gun fire, as many main battery guns as possible should be concentrated on as few units as possible.

Armament—As long as the gun continues to be the major weapon, the main function of the battleship will be to provide the best possible platform on which to bring it into action. Our guns should possess greater power and destructive effect than those of our most probable enemy, and, since they are now no larger, we must allow for even greater calibers than we have heretofore used. While it is true that in penetrative effect the 14-inch gun at probable battle ranges can pierce any armor that it is practicable to mount in a ship, still, if we accept the principle of maximum destructive effect, we are led almost inevitably to a 16-inch caliber. Such a gun is well within the limits of the present state of the ordnance art, and possesses 30 percent more destructive effect than the present 14-inch gun of our most probable enemies. The rapidity of fire of the larger gun can be made sensibly equal to that of the smaller, and the heavier weight of projectile will allow us to adopt a relatively low muzzle velocity, by means of which both erosion and dispersion will be diminished. Such a gun possesses a materially greater range, and the priority of gun fire thus gained constitutes a material advantage.* It also possesses a greater probability of hitting at long range, and one of the most significant lessons of the European war has been that engagements have been fought and decided at 16,000 yards—a range nearly 3 miles greater than our past estimate of probable battle range.

There is a further reason why we, of all nations, should adopt the larger caliber. Such a gun materially increases displacement and cost. When the present war is over we shall be the richest of nations, and therefore best able to afford the outlay incident to the adoption of the larger gun. Politically, therefore, this may be highly advisable, because of the depressing financial effect on possible enemies similar to that occasioned by the construction of the dreadnought class by England.

Disposition and Number of Battery.—Bearing in mind the value of concentration of armament and having decided the caliber of the main battery, we come to the best arrangement of the guns.

This is largely a function of the battle formation, and until such time as this shall seem to be logically other than line or column of divisions, or simple column, our centerline vertical-echelon disposition seems best. The question of just how many guns can be advantageously mounted is hardly subject to abstract determination, but it must be quite plain that there is a point at which, after considering the other elements of a design, more guns would only result in a positive loss of efficiency. From a purely constructional point of view, this point has been reached with the four-turret centerline mounting. So overwhelming, however, are the arguments in favor of maximum possible concentration, and so great a length must be provided to obtain the desired speed, that it will probably be best to add one more centerline turret. This is particularly necessary if the 16-inch caliber be adopted, because the problems of mounting such guns in triple-gun turrets are not yet solved, and in no other way can the demands of concentration of armament be satisfied.†

Speed.—For both strategical and tactical reasons high speed is extremely desirable. If we accept the principle that an active offense is the best defense, speed is essential both for bringing the enemy to action and for maintaining the most suitable range during action. Moreover, speed, when employed in skillful maneuver, assists us to gain that relative numerical superiority which is so essential for concentration. Later on it is proposed to recur to this question of speed in considering the length of battleships, and when the excessive cost of even 2 knots greater speed than that of the enemy is appreciated it is altogether probable that we should rely on fast battle-cruisers to gain the above advantages rather than attempt to attain too great superiority of speed with the battleships.

No other single feature of a ship has so large an influence on displacement, and every fraction of a knot sacrificed will allow the displacement to be reduced many hundreds of tons. Great ships of this type will always cruise in squadron, and the speed of the squadron will be the speed of the slowest unit. This speed is a function of so many variables—condition of bottom, quality of coal, skill of personnel, condition of machinery, danger of machinery troubles at maximum speeds—and the cost inci-

* See Baudry, "The Naval Battle," p. 116.

† For further arguments in favor of restricting the number of turrets to four, see Sir William White's paper before the Society of Naval Architects and Marine Engineers, 1910, and Lieutenant Viani's paper in Supplement to *Revista Maritime*, 1908.

dent to any material increase is so unreasonably great that it would seem wiser to adopt comparatively moderate speed.

Armor.—There will always be a difference of opinion as to the relative importance of guns, speed and armor, but in no one of these three military characteristics is there such a wide divergence of views as in the case of armor.

But the minimum reasonable requirement of armor, aside from the local protection of turrets, barbettes, conning-tower and base of smoke-pipes afforded by their own armor, is a belt extending high enough above the normal load waterline to protect the stability, buoyancy and vital military features of the ship, and extending low enough to guard against underwater hits due to naval action, rolling of ship, or heel due to damage. Coupled with this there should be at least one protective deck—all to be of the greatest practicable thickness.

Endurance.—Other great nations of the world as well as the United States have long since abandoned the fallacy of building battleships for coast defense, with consequent small radius of action. As previously pointed out, our battleships should be capable of waging successful war in the waters of our most probable enemies. This would hardly be practicable with a smaller radius of action than 8,000 miles at 12 knots. Fortunately, the advent of fuel oil, together with increased efficiency of ship-form and propulsive machinery, renders it possible to meet this claim with comparative ease.

Protection Against Torpedo Attack.—The gun seems certain to remain the supreme weapon of offense, but this superiority is challenged more and more by the formidable menace of the torpedo and mine. No battleship has ever been provided with any sure defense against either of these dangers, and the weakest feature of all existing battleships is their lack of adequate protection against underwater attack. Even now the largest unit of any fleet can be put almost, if not quite, "out of action" by a single torpedo, and in the future there is little to prevent the use of much larger explosive charges to offset any increased subdivision or underwater armor that may be provided. It seems probable, therefore, that the chief defense against this form of attack will consist in a somewhat increased speed of battleships and a cordon of high-speed units of the destroyer type.

This comparatively new effectiveness of the submarine and its weapon, the torpedo, must exercise a powerful influence on the size and cost of individual units, and it is not at all improbable that the eventual development of the submarine may result in driving the battleship from the sea. He would indeed be a rash prophet who would venture to predict when this will come to pass, but until then the development of the battleship type must move forward or else the type must be abandoned altogether.

Technical Limitations

Design.—The design of a battleship cannot be made according to mathematical formulæ. The several elements of a design may admit occasionally of scientific treatment by means of exact empirical formulæ—for example, the buoyancy, stability and speed. But a formula or law does not exist for combining the above elements with strength, endurance, protection and armament, and arriving at the best result. This has always been, is now, and in all probability will continue to be, a matter of opinion—or, rather, difference of opinion—and so let us leave it.

Dimensions.—Displacement is determined by the principal dimensions, length, breadth and depth, and by the form of the lines. Each dimension is determined with respect to absolutely different things, and each one must be thought out carefully by itself, never forgetting at the same time certain empirical ratios with respect to each other that have been found to exist in successful ships of similar design.

Draft.—This dimension is influenced chiefly by such practical considerations as the depth of harbors and docking accommodations. It would be well, at least until harbors and docks have been further enlarged, to restrict the normal load draft of our battleships to 30 feet, the deep load draft not to exceed 32 feet.

Beam.—The question of beam is determined somewhat with regard to width of docks,* but more with regard to stability, since the position of the metacenter is determined chiefly by the beam, and the metacentric height is the most important consideration affecting the movements of a ship in a seaway.

Exact formulæ for the influence of beam on speed do not exist, but model experiments seem to bear out the fact that on a given displacement for an increase of beam of, say, 5 percent, the effective horsepower must be increased by the same percentage if the same speed is dsired, and that if length be kept constant the ratio $\frac{B}{D}$ can be varied widely without any very appreciable effect on resistance.

Length.—This dimension is influenced more by the speed than by any other feature of the design. In order to obtain high speed it is absolutely necessary to have length. Not only will the shorter ship require much more horsepower for a given speed, but affords less length for the installation of the increased horsepower, so that practically the length must be great enough to enable the necessary machinery to be installed.

On the other hand, by a too great increase in length we reach a point where the frictional resistance due to increased wetted surface is greater than the gain from reduced wave-making resistance, particularly at cruising speeds. Length is not favorable for maneuvering, increasing the resistance to turning. Length necessitates a serious increase in displacement, due to the greater weight of armor and hull for the same protection and same length. Greater length means greater target area, and incidentally there are but few dry docks that will accommodate great lengths.

Displacement.—Many other features must be given their relative weight, the chief of which are seaworthiness, freeboard, and type of hull fittings, but enough has been said to indicate the principal military and technical considerations influencing and limiting battleship displacement.

Passing over the more or less mechanical end of the calculations involved, it may be stated that, in the present state of the art of the naval architect and marine engineer, it is not possible to adequately fulfill these principal claims on less dimensions than 640 feet for length, 96 feet for beam and 30 feet for draft, with a consequent displacement of approximately 36,000 tons.

Cost

A study of the relative costs of large and small battleships should properly include not only the first or "prime" cost, but the cost of maintenance as well. As regards first cost, perhaps the briefest way to indicate the practical relation in battleship construction existing between cost, displacement and effective gun power is to state that, by increasing the cost one-half and the displacement one-third, it is possible to produce a unit with double the effective gun fire.

Consequently, if smaller and more numerous units are

* It is limited, for the present, at least, by the 110-foot width of the Panama Canal locks.

constructed for the same expenditure, each with an effective gun fire equal to one-half that of our type ship, we may expect to provide only three smaller vessels for every two larger ones; and the effective gun power of the two large ships would be one-third greater than that of the three smaller ships (i. e., in the proportion of 2 to 1.5). Moreover, the cost per annum of manning and maintaining the more numerous fleet will be materially greater. It may be conservatively estimated that this increased cost of maintenance of the three small ships over that of the two larger ones will be less than 5 percent per annum. Assuming the life of a capital ship to be twenty years, it will cost 100 percent more to man and maintain the more numerous fleet. It is also to be observed that, although the cost per unit for "large" ships is much greater, the risk of total loss is correspondingly smaller on account of the better subdivision possible to provide on the larger ship, and the greater distance from the skin of the ship at which it is possible to place the boilers and magazines.

Fighting Value

Many advantages of the larger units become greater and more accentuated when the fighting value of a fleet of units is considered. This is particularly true when we compare fleets of equal cost. It has been shown that for a given expenditure of money it is possible to provide one-third more gun power on larger vessels than on smaller vessels each of gun power equivalent to one-half the larger vessels.

If the caliber of guns in the two fleets be assumed equal, then the larger ships possess a one-third greater numerical superiority. This would indicate that the fighting power of the large ships with relation to that of the small ships is in the proportion of

$$\left(\frac{4}{3}\right)^2 = \frac{16}{9} = 1.77.$$

Furthermore, the destructive value of a fleet is determined not only by the fighting value of its units, but by the method of employing that fighting value. The principal factors in connection with the method of employing fighting value are (1) maneuver, and (2) fire control. Maneuver enables a fleet to gain that relative numerical superiority of guns required by the principle of concentration. The fewer number of units in the fleet of large ships allows a greater ease of maneuver on account of the handiness of a short line as compared with the clumsiness of a long one, apart from such matters as visability of signals, etc. If it is argued that the smaller, and therefore more numerous, fleet possesses a larger power of combination, the answer is that in a naval battle it is not power of combination that we desire, but power of concentration.

From the point of view of fire control, the big ship again has a great advantage. Assume three small ships fighting one large one. To anyone who has witnessed long-range target practice and attempted to spot the fall of salvos, it is at once apparent how extremely difficult, if not indeed impossible, it would be to identify the salvos of the three smaller ships as they fall about the large one, whereas the fire-control officer and spotter of the single large ship can concentrate their salvos on either one or two of the smaller ships, identifying unerringly each salvo. The advantage of the small ships due to the "dispersion of target" offered by them would be more than counterbalanced by the great handicap of being unable to identify their salvos.

Conclusion

Since the ultimate purpose in modern war is the disruption and destruction of the organized forces of the enemy, the purpose of our battleship fleet is neither the defense of our coast, the blockade of the enemy's fleet in his ports, the capture of sea-coast forts, nor even the "command of the sea." Its mission—its sole mission—is battle, the complete and relentless destruction of the enemy's battle fleet. To this end it must possess at the outset and maintain by maneuver during battle that relative superiority which is the key of all decisive battles by land or by sea. This can be obtained most certainly, and at a much less cost per gun, by concentration of fighting power in large units.

It has been shown that the fulfilment of the present-day claims on the military and technical characteristics of battleship design imperatively demands a ship of large displacement. It has also been shown how each element of a design can be benefited by an increase of displacement. Apart, however, from this gain, the larger ship possesses certain inherent advantages over the smaller one that more than outweigh the disadvantages due to size:

Greater concentration of armament.

Better protection of buoyancy and stability by comparatively more minute subdivision.

Greater protection by armor, because the thickness of armor need not be increased with displacement, and the same area will protect a greater tonnage.

More economical propulsion.

Greater radius of action.

Greater sustained sea speed under all conditions of weather.

Greater efficiency per gun due to the wide separation of turrets, machinery, magazines, etc., also on account of the greater safeguards it is possible to provide on the large ship with regard to the supply of power, ammunition and every other essential that serves the gun.

Moreover, it is only large displacement which makes it possible to provide that adequate protection against underwater attack which is becoming more and more necessary and which cannot be provided with smaller displacements.

These are the reasons that demonstrate so convincingly the value of the larger ship and that will force us inevitably to build larger and even larger units until such time as the improvement in submarine and aerial offense shall drive the present battleship type from the sea forever.

Werkspoor Marine Diesel Engine

In a paper presented at the recent annual meeting of the American Society of Mechanical Engineers, Mr. Thomas O. Lisle reviewed the results of six years' development of the Werkspoor marine Diesel engine. The firm of Werkspoor has to date completed the engines of twenty-four sea-going mercantile ships, representing a total of about 35,000 horsepower.

Werkspoor was one of the first firms in the world to build Diesel-type engines on an extensive scale, having been building stationary motors of this class for over sixteen years. Despite this experience, and although they had also the benefit of about half a century's marine engine construction, their first attempts at building the machinery of motor ships were most modest. When the firm first turned its attention to marine Diesel engines, it decided that, unless the engine can be repaired in any port in the world where steam engines can be repaired, it is of no use to ocean-going ships. To this day they have adhered to this policy, consequently their engine is exactly similar to any of the marine steam engines.

The review included illustrations taken from the engines of the twenty-four vessels constructed by the concern.

THE STANDARD SHIPBUILDING CORPORATION

Builders of Standard Freight Steamers

Fig. 1. -General View of Shooters Island Shipyard

Fig. 2.—Interior of Machine Shop

24180

Fig. 3.—Ship Ways of Standard Shipbuilding Corporation

The Standard Shipbuilding Corporation and Its Standard Ship

New Equipment Installed at Shooters Island Shipyard for Building Standard Cargo Vessels—Capacity of Eighteen Ships a Year Planned

WHAT Henry Ford has done with automobiles, the Standard Shipbuilding Corporation, of New York, is doing with merchant ships: it has adopted one single type and size as standard and will turn out nothing else.

Those not familiar with manufacturing processes may question the advantages of this policy of standardization and wonder what is gained by restricting one's product in so rigid a fashion. But a brief outline of the method pursued by the Standard Corporation will make clear why the adherence to a definite standard benefits greatly both builder and buyer.

After an extensive preliminary investigation a model vessel that will suit the great majority of users was selected as the standard. Since there was to be only one design it could be drawn up with the greatest care, and neither time, effort, nor expense spared to make it as perfect as possible and provide all of the proven and most efficient equipment.

Each part, from the largest to the smallest, is standardized and a special machine assigned to its production, thus insuring the utmost rapidity of output and the highest operating economy.

When one of these standard ships is to be built every

Fig. 4.—24-Foot Plate Planer

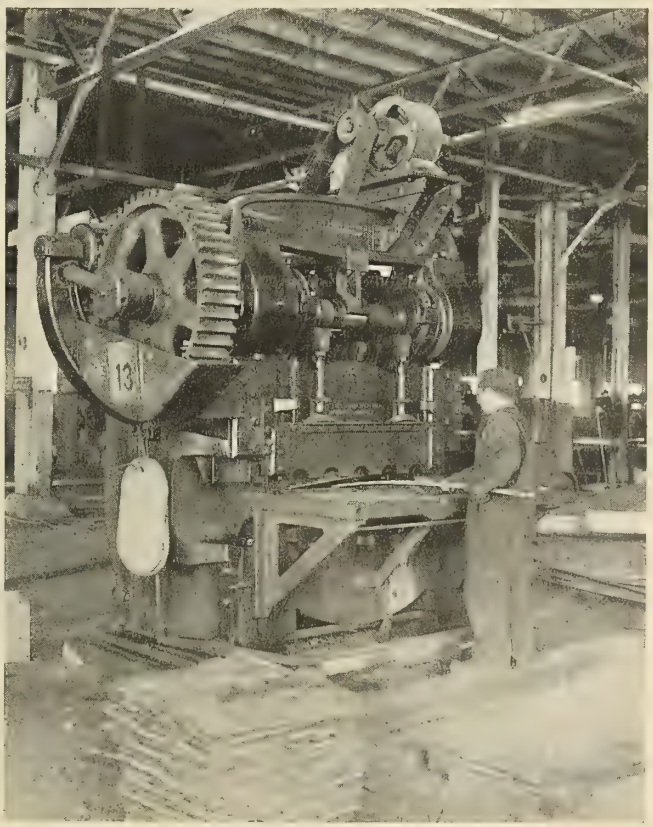


Fig. 5.—Gate Shear

THE STANDARD SHIPBUILDING CORPORATION

Builders of Standard Freight Steamers

Fig. 6.—Marine Railway

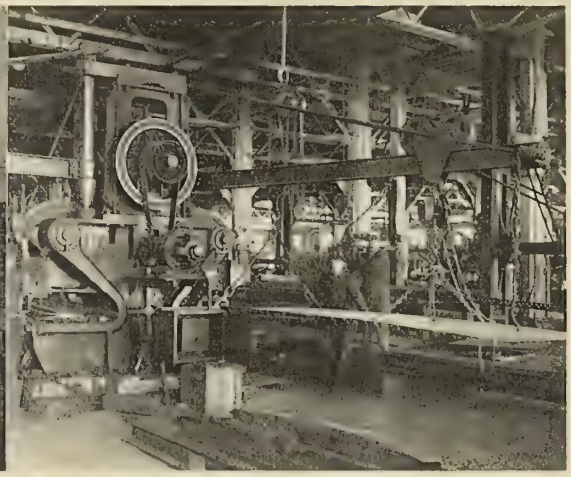


Fig. 7.—Punch and Shear

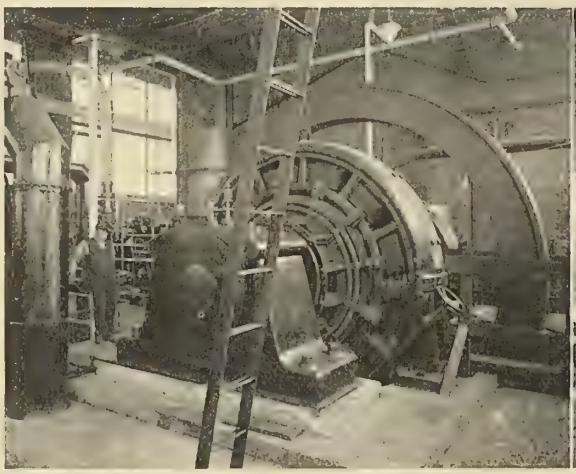


Fig. 8.—Power House. 500-Kilowatt Westinghouse Generators

Fig. 9.—Pattern Shop

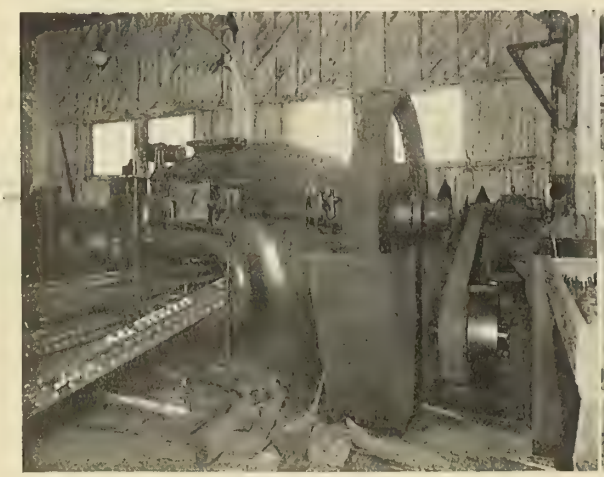


Fig. 10.—Punch

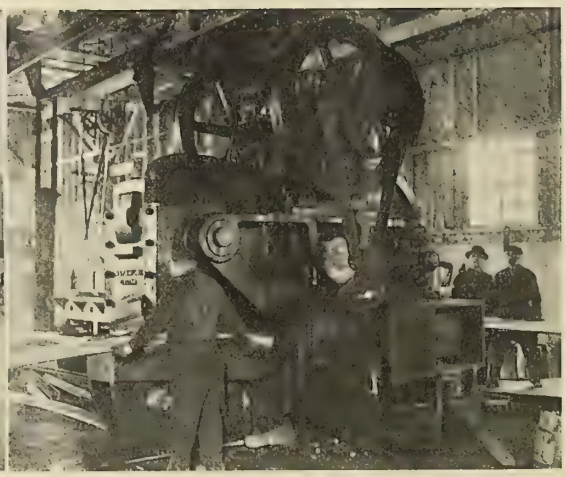


Fig. 11.—Punch and Shear

item that goes into her is completed and ready for erection. The standard parts are handled in a standard manner, according to a standard schedule, and fitted together in a standard way. Each workman does the same identical thing that he has done many times before, so that the whole operation goes like clockwork and the ship is put together and launched within the shortest possible time and at the lowest possible cost.

THE STANDARD SHIP

Of course, this is not an entirely new idea. It has been attempted before, but always, heretofore, some changes have been made for one purchaser, other changes for the next, and so on, until at last each ship is being specially built, and the standard has vanished. "We shall do nothing like that," says the Standard Shipbuilding Corporation. "We will give the purchaser the best ship we are able to produce, along lines which have been proved by experience to be the most adaptable for general cargo service, and we believe that such a ship will prove to be the most satisfactory to the purchaser in the long run."

The details of this standard cargo steamship are as follows:

Length	392 feet
Beam	52 feet
Deadweight capacity	7,300 tons
Indicated horsepower	2,500
Speed	10½ knots

She will have the latest appliances for handling the cargo and for insuring the safety and comfort of the crew, and will be classed + 100 A-1 by Lloyd's.

THE REMODELED SHIPYARD

The yard is located on Shooters Island, which is just off Staten Island in New York harbor. An old plant was purchased and entirely remodeled to suit the new requirements. One feature of the remodeling was the modernizing of the drive of the various machines. Originally each machine—shear, punch, roll, etc.—was driven by steam engines. With such a drive rapid and economical production is an impossibility, so that Westinghouse electric motors were installed throughout. The application of these motors proved, however, quite a problem, for a large part of the machinery was of sturdy Scotch construction and nothing was known in this country about its power requirements. A careful study of each machine was made by the motor manufacturers, and a system of belted motor drive installed that has proved perfectly satisfactory in every respect. Power for the motors is supplied by a 500-kilowatt Westinghouse generator.

In the plate shop, individual motors are used for each machine, as this gives the most satisfactory drive with the least complication of belts and line shafting. Each machine is independent, can be located wherever desired, its position changed without difficulty, and trouble with one machine does not affect the operation of any other.

In the machine shop the original line shaft drive is still in use, four motors at present driving all the machinery, but the new machine tools being installed are all individually motor-driven.

Operations were started by the Standard Corporation in January, 1916, and six modern shipbuilding berths have been provided. The first three ships are well along, the keels having been laid in October, and the fabrication of the second three ships is well advanced.

The latest and most modern equipment, shops, etc., are being installed in addition to that already in operation, and when completed the plant will have a capacity of eighteen standard cargo steamers per year.

Typical Refrigerating Plants for Ships' Stores on Ocean-Going Cargo Vessels

For the benefit of those of our readers who are interested in the refrigeration of ships' stores, we present the following descriptions of two refrigerating installations on ocean-going cargo vessels as carried out by the Shipley Construction & Supply Company, of Brooklyn, N. Y.

Fig. 2 shows in detail the arrangement of the cold room and York ammonia refrigerating machine, as fitted on the steamship *Valdivia*. It will be of interest to know that this entire installation of cold room installation and machinery complete was installed and operated ready to receive provisions between Wednesday morning and Saturday night, the time during which the vessel was loading outward freight in New York harbor.

The space occupied by the cold room is located on the port side in the upper 'tween deck space, abaft the engine

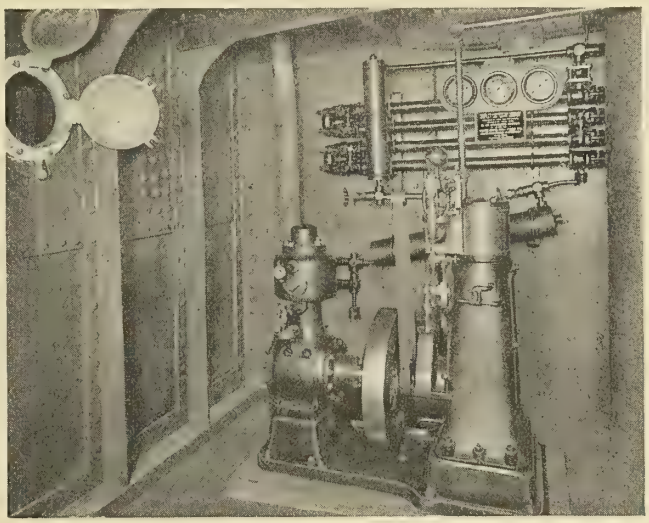


Fig. 1.—York Refrigerating Plant Installed on Steamship *Valdivia*

room bulkhead, and is contained in a steel casing forming a trunkway on the port side of No. 3 cargo hatch. This feature was specially desirable, as it enabled two doors to be placed in the cold chamber, one on the starboard side and the other on the forward end. The door on the starboard side opens into the trunked hatchway and enabled the provisions to be loaded into the cold room directly from the hatchway, and to be removed for the steward's department, as required, through the door in the forward end leading to the passageway, direct to the ship's galley and pantry.

The capacity of the cold chamber is 450 cubic feet. The chamber is fitted on its port and starboard sides and after ends with direct expansion ammonia cooling coils, which are clearly shown in the plans. Over these cooling coils are placed battens to prevent the provisions from coming into direct contact with the cooling coils. A slatted rack is provided along the whole length of the starboard side for the convenient stowage of small provisions, and, in addition, three meat rails are provided under the deck the whole length of the room, enabling beef to be hung in quarters. It will be noted that the insulation throughout consists of 6 inches of regranulated cork packed between the ship's frames on the port side, the ship's beams overhead, the casing stiffeners on the aft end and starboard side, and between uprights on the forward end.

The temperatures in the room are maintained at about 28 degrees, which is sufficiently cool for the purpose of cooling ships' stores. Fig. 2 shows the position of the

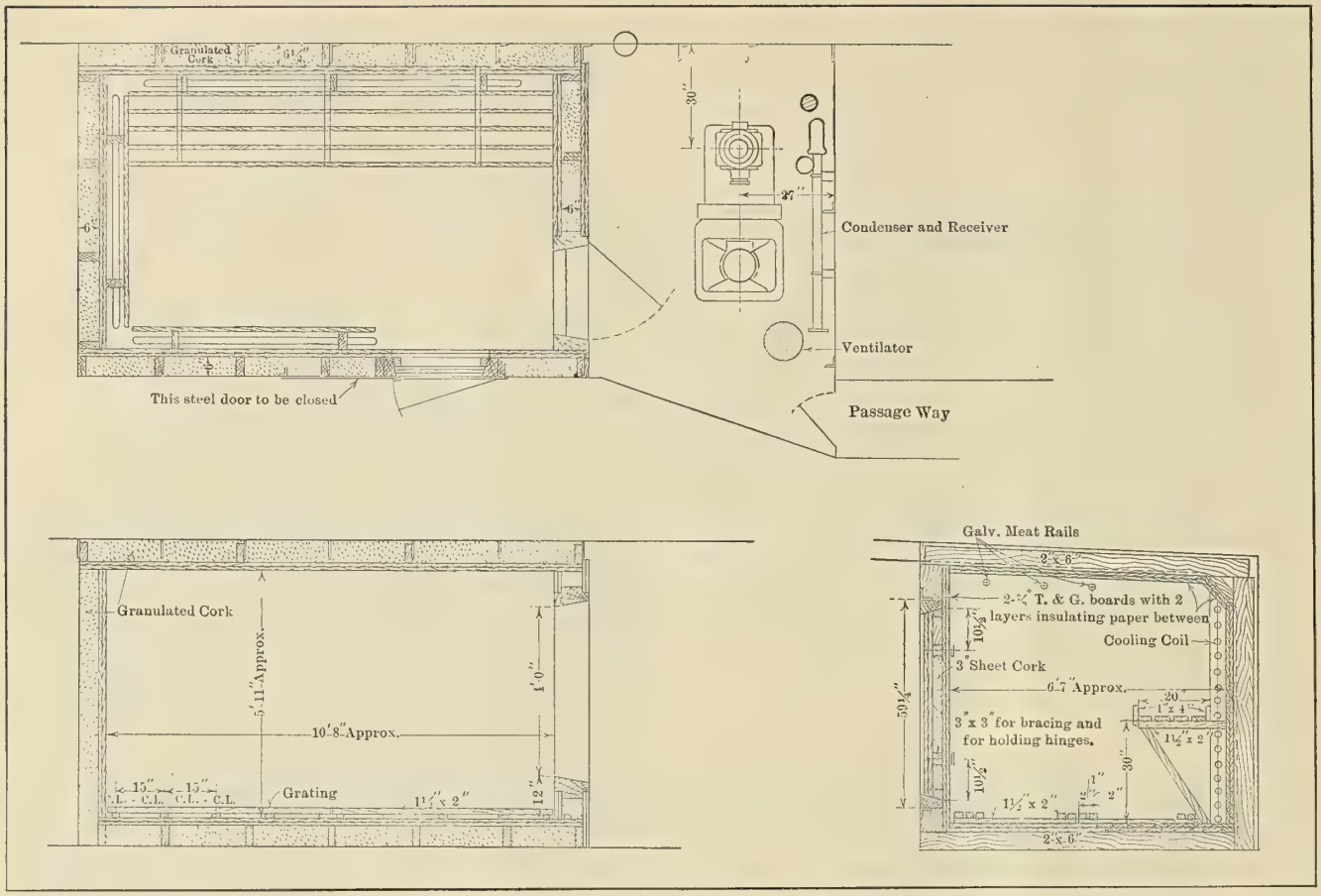


Fig. 2.—Refrigerating Rooms and Machinery, S. S. *Valdivia*

cooling coils which are entirely on the sides, and also the details of the gratings, shelving and cargo battens provided in the cold room. The refrigerating machinery, as shown in Fig. 1, is placed at the forward end of the cold room, and consists of a one-ton York steam-driven, vertical refrigerating machine, with its condenser, oil separator, and liquid ammonia receiver, forming a self-contained unit. The space occupied by this machinery is 5 feet long and 3 feet 6 inches in width, but the machine room space is sufficiently large to allow ample handling room for operation and overhauling, and to make use of the existing sidelight (shown on the port side in the first frame space forward of the cold room) and the ventilator passing through the machinery space.

At sea these machines are very economical in their

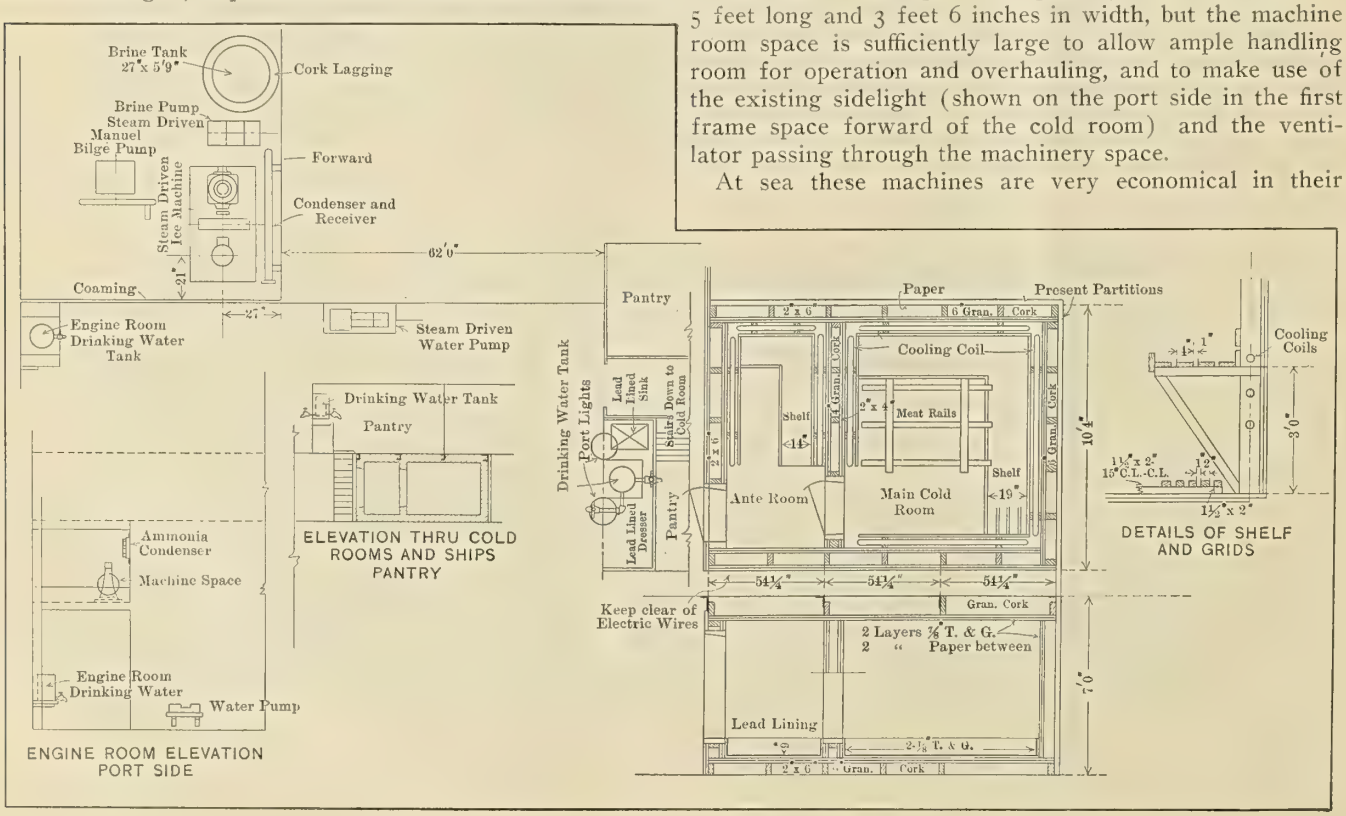


Fig. 3.—Refrigerating Rooms and Machinery on S. S. *Arna*

operation, as the exhaust steam can be utilized through the feed water heater, and so return the greater part of its heat energy for further use. The engine and compressor are of the enclosed, automatic lubrication type, and therefore require very little attention on the part of the engineering staff.

It will be noted that as the cold room and the refrigerating machinery room are adjacent to one another, very short lines of ammonia piping can be utilized, with resultingly few joints and a corresponding reduction in the chances of ammonia leakage.

Where the machinery and cold room may be similarly located, this type of installation is perhaps the simplest and least troublesome that can be fitted, and there are many hundreds of such installations in daily use, all giving first-class satisfaction. Where the cold room is to be situated at a coniderable distance from the refrigerating machinery, it is inadvisable to use ammonia as a direct cooling agent in the cold chambers, on account of the possibility of leakage by the fracture of a pipe where the ammonia pipes are carried through cargo spaces or bunkers.

In such cases it is convenient to use brine as a direct cooling agent for the chambers and provide, in addition to the equipment enumerated for the steamship *Valdivia,* a brine cooling tank and brine circulating pump, so that the brine tank may be placed adjacent to the refrigerating machine. The tank is fitted with a brine cooling coil by means of which the ammonia machine cools the brine in the tank. The cold brine is then circulated by means of the brine pump through the cold rooms or other parts to be cooled and returned to the brine tank for re-use, forming a complete brine cycle.

Fig. 3 illustrates such a plant recently installed by the same company on the Norwegian steamship *Arna* in the port of New York. The installation was commenced on Tuesday and completed on the following Monday, during the time the vessel was loading cargo in this port. The plant, as already stated, consists of a one-ton York steam-driven ammonia machine, with its condenser, oil separator and ammonia receiver, a brine cooling tank, brine pump and water circulating pump, both steam-driven, also two insulated drinking water tanks and two cold rooms.

The cold room space is subdivided into a main and ante-room, both piped, and fitted with gratings, shelves and battens for the brine pipes. The inner room is used as a main storage for provisions and the ante-room as a daily requirement storage. This arrangement is very satisfactory, both to the steward's and engineering departments of the vessel, as it is unnecessary to open the door leading to the main room frequently. A suitable temperature for this room with its contents can then be more easily maintained than would be the case if the door to the outside warm air had to be continually opened. This arrangement is recommended by the manufacturers wherever possible to all users of refrigerating machinery for this purpose.

The drinking water-cooling tanks are cooled by a separate brine circulation independently controlled. One is placed in a convenient position for easy access on the port side of the lower platform in the main engine room and furnishes cold drinking water for the engine room staff. The other is placed in the pantry amidships, furnishing cold drinking water to the steward's department and the men in the deck department. The latter draw their drinking water from a spring-controlled, self-closing tap, placed on the outside of the deck house. Water for pantry use is drawn from a self-closing faucet placed directly in the pantry.

The construction of the cold chambers is similar to that described for the steamship *Valdivia,* and consists of 6 inches of regranulated cork. It will be noted that the fore and aft distance between the after end of the pantry and the forward end of the machinery space is 62 feet and about 200 feet of brine discharge and return piping were required to connect the brine pump, cold rooms, drinking water tanks and brine tank. This piping was carried through the port 'tween deck bunker space, heavily insulated with molded cork covering and further protected by heavy wooden casings.

The knowledge of such installations should convince owners that their existing cargo vessels may be readily fitted with complete refrigerating equipment for ships' stores during the time the vessel is working cargo in port. It frequently has been demonstrated that when ships' stores are carried in properly fitted and fully equipped refrigerated spaces as compared with the old method of storing provisions with ice, there is a resulting gain, not only from the cost of installing and operating the refrigerating machinery as compared with the cost of ice, but there is a further decided saving in the cost of provisioning the vessel, due to the food being kept in a better and more sanitary condition, eliminating almost entirely losses due to rotting of provisions.

The United States Coast Guard

According to the annual report of the United States Coast Guard, recently issued, the lives of 1,216 persons were actually saved during the fiscal year ended June 30, 1916, through the agency of the Coast Guard cutters and stations. There were 1,453 instances of service involving the saving of life or the salving of property imperiled. Assistance was given in various ways to 15,742 persons on board vessels. The total appraised value of property saved from immediate jeopardy was $10,638,555 (£2,180,000). The cost of maintaining the service for the year was $5,215,711.34 (£1,070,000). During the entire year there were but three days when the Coast Guard was not actively engaged in some form of public benefaction. The daily average number of cases for the year involving rescue work was approximately ten, while the maximum number for any one day was 77. These results emphasize the great importance of keeping the cutters and stations in the highest state of efficiency and readiness in order that they may promptly and adequately at all times meet the calls of assistance coming from the various sources of need.

The removal or destruction of dangerous derelicts in the paths of steamers has been prosecuted with the usual vigor in the past year. There were thirty of these menaces destroyed or otherwise removed. The past year was the last of ten years since records have been compiled of this activity. During that decade 268 derelicts were destroyed or removed—an average of 26.8 per year.

The equipment of the Coast Guard includes 23 cruising cutters, 24 harbor cutters and 279 stations. Recommendations are made in the report for the appropriation of $350,000 (£72,000) for the construction of a new cruising cutter to replace the *Morrill,* stationed at Detroit, Mich., which is now twenty-seven years old and is too antiquated and entirely inadequate in size and power effectively to perform the duties required at this station. An appropriation of $400,000 (£82,000) is also recommended to provide a cutter for replacing the *Thetis,* formerly stationed at Honolulu, which it was found necessary to condemn and dispose of. The dangerous vicinity off Cape Hatteras is also in urgent need of an efficient Coast Guard cutter to supplement the work of the *Onondaga,* stationed at Norfolk, Va., and the *Seminole,* with headquarters at Wilmington, N. C.

Why is a Door?

"Old Mac," the Practical Ship Draftsman, During the Noon Hour Gives "the Cubs" Some Useful Advice About Doors

YOUNG Stevens and Tek Johnson were having an argument about the proper way to calculate the strength and deflection of a watertight bulkhead. It was noon time and they had picked up a preliminary copy of an article to be read at a coming meeting of the Society of Naval Architects.

Tek (so nicknamed because he is our latest arrival from college) had his slide rule, which was a high-priced instrument on which were numerous extra and mysterious scales. He was proving a lot of imaginary things with it and was getting decidedly the best of young Stevens, until Old Mac came in.

Old Mac had just finished his pipe and taken his daily turn around the yard. As he came down the office through the line of boards he overheard part of the argument. As he and the elder Stevens are strong friends, Mac rather looks after young Stevens in the drawing room.

Although Mac is a bachelor and the office knows that he generally keeps the kids off at arm's length, nevertheless he has made an exception of young Stevens. The old maid stenographer always says that Stevens, Sr., and Mac used to take candy to the same girl, and that young Stevens looks like his mother—hence the soft spot.

Mac went over to his board, knocked the ashes out of his pipe, hung up his hat and sat listening to the argument. Tek was surely getting the best of it. Mac took off his glasses, laid them on the board in front of him and thoughtfully scratched his nose where the glasses had left a red line. All morning he had been listening to the vague talk of an owner's inspector, who, in possession of a little knowledge of the game, had conceived the idea that it was his mission in life to revolutionize the shipbuilding business. Mac had nearly exploded a couple of times, and as he listened to Tek his patience finally became exhausted, and he called out:

"Hey! You kids, come over here! What do you know about bulkhead stiffeners, anyway? Neither one of you can make a good, legible tracing yet. Tek, if you ever get a bulkhead to draw, don't worry about stiffeners—they will be specified. Throw that freak slide rule in the waste basket, shut up and learn to trace. Who do you think you are, anyway?"

Tek was rather taken back, but he loves his slide r and is kind of stubborn, so he came back with, "Don't the chief want us to learn all we can?"

"Sure he does," replied Mac, "but study something practical and possible. The fellow who wrote that article has time and money to spare and wants to advertise. Yo don't want to advertise because if you are too well known you will lose your job. Lay low. You know why you washed out that last tracing you nearly finished. All tracing cloth is not made for pen wipers, you know. The scraps are enough."

"Well, what do you want me to do?" asked Tek.

"Trade that slide rule for a flock of two-foot rules and go down in the yard and measure up some of the common things you have got to know well before you can draw at all," said Mac. "Remember that the fellow who draws best, draws the most water and the largest check at the end of the month."

"What do you want me to measure, for instance?" asked Tek.

"Well, now, I'll tell you," replied Mac; "I am going to ask you kids some questions every once in awhile, and what you don't know, find out in the yard.

"In the first place, why is a door?"

"What do you mean?" asked the boys.

"Why do we have them; how big are they; what do they weigh and what do they cost, etc.? Listen and I will tell you something about doors that is not in books, and something that a first-class draftsman has got to know.

"A door serves as a passageway and also serves to close up that passageway. Yes, you know all that, but maybe you do not know that a whole lot of times young fellows like you have drawn in doors that could not be opened and have felt mighty cheap when some noisy fellow in the yard found it out when he tried to do it and couldn't. Oftentimes there are deck beams, bulkhead stiffeners, stiffener brackets, deck foundation stiffening, piping, etc., that block a door completely.

"A good, standard watertight door has a clear opening 24 inches wide by 5 feet high. The top of this opening is located to give head room or the bottom may be located high enough to suit the coaming that may form part of the bulkhead or casing. Good head room is 6 feet or 6 feet 2 inches. Some people put the bottom of the opening uniformly 9 inches above the deck. In this case you have to duck your head a little, but you do not have to step so high. Such doors have dogs that jam a rubber gasket on the door proper against the door frame on the budkhead.

"Simpson's handbook gives a good door detail, and every yard that has built more than one ship has a standard door plan. If you ever have to draw in such a door, be careful to see that the door will open and the stiffener next the hinge side of the door clears the hinges and that the dogs, handle, etc., don't foul other stiffeners and prevent the door from stowing out of the way.

"A 5-foot 2-inch, watertight door weighs, complete, about 575 pounds and costs, installed, roughly, $175 (36/9/2). These are approximate figures, of course, but for a couple of kids who might at a guess give the weight of such a door at from 100 to 1,000 pounds they are good enough to get ideas properly formed.

"Non-watertig t doors are lighter, cheaper and generally larger. They are made to suit house or casing plating. Here, a 5-foot 2-inch or 5-foot 6-inch by 2-foot 2-inch door is a good standard size. This door is nothing more than a plate that lands on the heel or toe of the casing stiffeners and has a stiffening flat iron piece around the edge that projects enough to cover the crack and give a finish. A non-watertight door 5 feet 6 inches by 2 feet 2 inches will weigh about 175 pounds and cost about $40 (8/6/8) installed. These doors are simple, but the drawing office has generally to order the hardware.

"This hardware is important, and more than once the store has had to use its friendly relations with the manufacturer to straighten out some wild bill of material that some inexperienced draftsman has innocently inflicted upon the yard.

"The hinges are steel-drop forgings generally. The male part is riveted to the door proper and the pin is about ¾ inch diameter. These doors generally hinge forward and out and have a fairly heavy bronze rim lock. Reversible locks can be bought, but often rights and lefts have to be ordered. This is the way you distinguish. Imagine that you stand opening the door away from you.

The hand that you take hold of the knob with is the hand of the lock and hinges. See, here is a sketch, right-left.

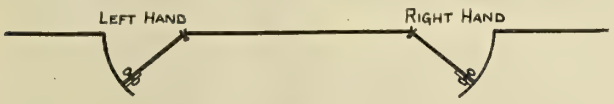


Fig. 1

"These locks have a striker, knobs (sometimes ring handles) and a key. The knob is about 42 inches above the deck unless some detail of the door finish, such as the size of the panel, etc., makes it necessary to move it higher or lower. Sometimes a lock is not fitted, but only a sliding bolt is used. Remember also that some kind of a hook must be furnished to hold the door open. They are heavy, and a ship rolls and pitches and the wind blows. A hook about ¼ inch in diameter and fastened to the door and casing by a small-shouldered eye bolt (⅜ inch diameter) does nicely.

"The door plate is the same weight or lighter than the casing plating, and the bottom of the opening is the top of the coaming. A horizontal stiffener usually forms the sill, but sometimes a cast brass sill is fitted and fastened to the coaming and the vertical stiffeners. Brass or enameled name plates are fitted to the door or to the casing just above. The door that has a sliding bolt has a handle.

"In the quarters wooden doors are used, and here, as in the case of the steel door, the drawing office has to worry out the hardware. Rim and mortise locks are used. A rim lock is fastened on the face or rim of the door, while the mortise lock is mortised or let into the door. Rights and lefts may be ordered and key-hole plates must be thought of. The hinges for such doors are listed in the catalogues as butts, and are measured with the leaves extended, as shown in Fig. 2.

"This is a 4-inch by 4-inch. The length dimension must be given first. Many a brave lad who did not know better has called this a 4-inch by 2-inch, and has been called down for it. There are acorn and plain top hinges and hinges with a loose pin, tight pin, and loose joint. Be careful. Two hinges located about 12 inches from top and bottom are enough for the ordinary door.

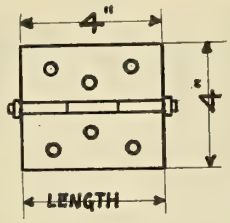


Fig. 2

"A cast brass sill may be fitted, as in the case of the steel door, or a sheet brass piece may be used instead. I remember when I took a lot of pride and wasted a lot of time putting the ship's name in copper tacks on some of these sills.

"When light sheet metal bulkheads are used—tin bulkheads they call them—sheet metal doors are fitted, instead of wooden doors. These doors cost about $40 (8/6/8) and weigh about 90 pounds, complete, with a trim that is fitted to and forms part of the tin bulkhead. Such doors are generally bought on the outside and the drawing office has only to give the size, right or left hand, etc. The door manufacturer furnishes the hardware and sends the door painted and ready to put in place. Sometimes they are fairly elaborate and have glass panels, sliding blinds, etc."

The whistle blew. Old Mac picked up his glasses and Tek beat it. Young Stevens hung around, and finally asked how he could remember all the things Mac had told him.

"When you see a door in your travels," continued Mac, "size it up and notice the hardware on it. Talk to the fellows on the ship who are puting it up. In a little while you will have it down fine and with a very little effort. You will have acquired a practical point of view and see a lot of important things that these slide-rule fellows don't know exist. Cut out this theoretical stuff. It don't get you anywhere, wastes your time and fills up your head to the exclusion of profitable, practical things."

Stevens went to work impressed.

Later in the afternoon Old Mac looked around. Tek was monkeying with his slide rule. Mac watched him awhile, and it seemed to me that he was trying to figure how Tek was using his slide rule to trace with. Then he looked at Young Stevens, who was busy tracing and oblivious to the rest of the office. His look seemed to go beyond Stevens, and his face softened.

Somehow, as I watched him, I was convinced that the old maid stenographer is right about the candy episode. Finally, he shrugged his shoulders and went to work again.

He surely would have gone up in the air if he had known that Tek had been trying for some time to see if he could find some way of figuring the cost of a door from its weight and adding another constant to the back of his already mysterious slide rule.

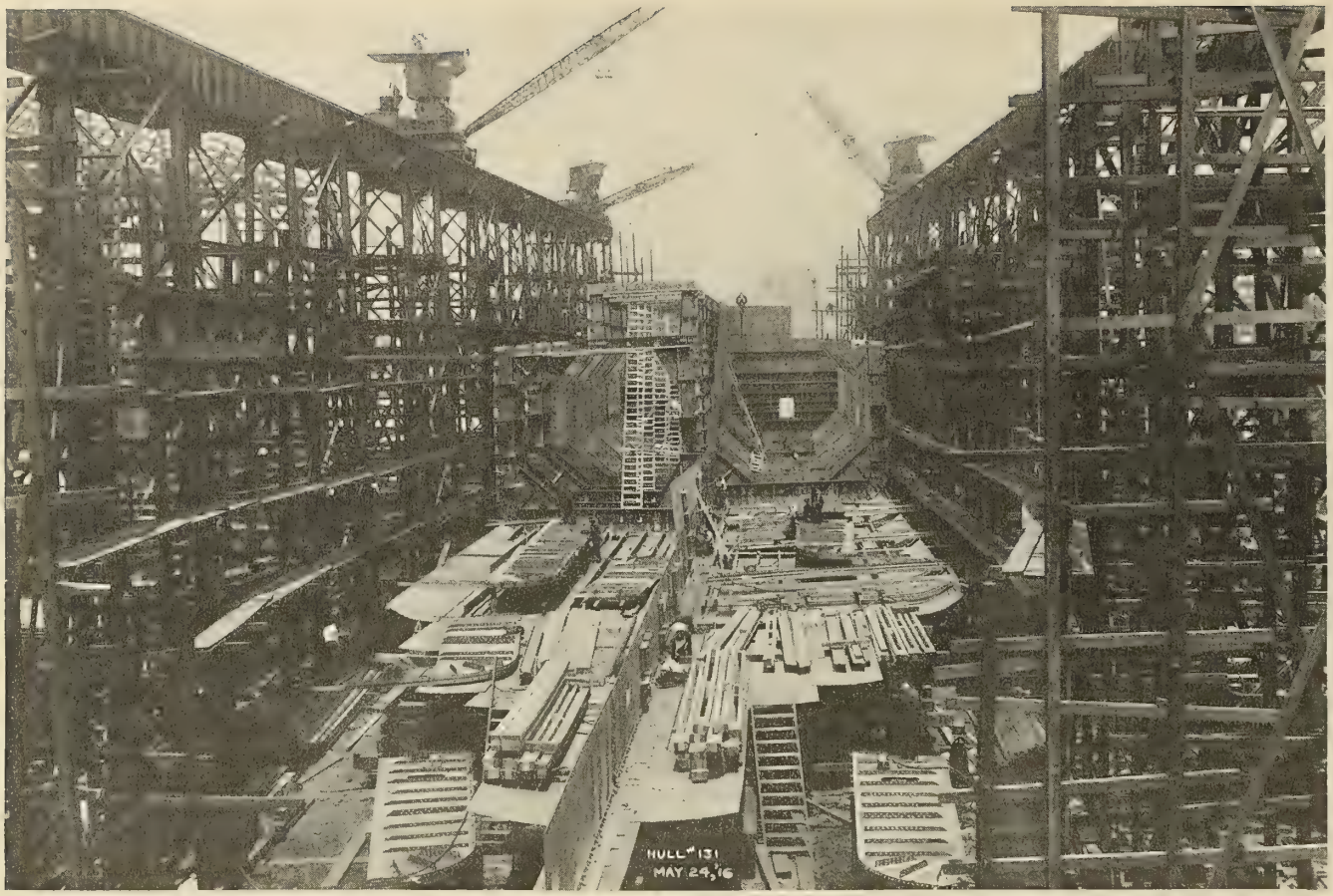
Saving in Construction of Battleship Arizona

The construction of the battleship *Arizona* at the New York Navy Yard, according to the annual report of the Secretary of the Navy, demonstrates that there has been an increase of efficiency in new construction at that yard. The actual cost of the *Arizona* as compared with that of the *New York* and *Florida*, the preceding battleships built at the New York Yard, was much less, notwithstanding the present strenuous conditions due to the great war in Europe, which has increased all expenses for material and labor in shipbuilding in this country.

The actual saving as reported by Captain G. E. Burd, industrial manager of the New York yard, in the construction of the *Arizona*, was $678,239.82 (£139,000), but due to the scarcity of labor it was necessary to pay $133,729.95 (£27,400) in bonuses for overtime work which would not have been required in ordinary times. Without the payment of bonuses the saving would have been $811,969.77 (£166,400)

The comparison of the cost per ton of the *Florida, New York* and *Arizona* is illuminating. The cost per ton for building the *Florida* was $286 (£58.7); for building the *New York*, $233.53 (£47.9), and for the *Arizona*, $210.62 (£43.2). That this decrease in cost per ton was made notwithstanding the considerable increase in wages and cost of material and increasing number of expensive appliances installed on new ships, demonstrates, in the opinion of the Secretary of the Navy, the wisdom of ordering the construction of this ship at the New York Navy Yard.

At the beginning of Secretary Daniels' administration but one navy yard was equipped for building battleships, that was the New York Navy Yard, and only one other navy yard—that at Mare Island—was equipped for building auxiliary vessels. As the cost of all the United States navy yards and their equipment represented an investment of about $150,000,000 (£30,750,000), steps were taken to utilize to a far greater extent these expensive plants for building naval vessels. At the present time battleships are under construction at two of the navy yards, auxiliary vessels at two others, destroyers at two others, and submarines at still another navy yard. In addition to this, the recent naval act authorizes the expenditure of $6,000,000 (£1,230,000) for further fitting of navy yards for shipbuilding.



The Construction of Oil Tank Steamships Has Been a Prominent Feature of the Year's Work in American Shipyards. Oil Tanker Under Construction at the Union Iron Works, San Francisco

Shipbuilding in the United States in 1916

Over 500 Merchant Vessels of 1,718,338 Gross Tons Now Under Construction—263 Merchant Vessels of 491,161 Gross Tons Built in 1916

ACCORDING to reports sent to MARINE ENGINEERING from practically every shipyard in the United States, there are at the present time under construction in the private shipyards of the country 506 merchant vessels of 1,718,338 gross tons. In addition to the merchant work the private shipyards are building 53 naval vessels aggregating 174,021 tons.

The output of the private yards during 1916 amounted to 263 merchant vessels of 491,161 gross tons and 15 naval vessels of 45,925 tons.

The character of the output is significant, as it consists principally of sea-going cargo boats and oil tankers. In 1916, 47 sea-going freight steamers of 186,493 gross tons were built and 27 oil tank steamships of 180,156 gross tons. In the work now on hand there are 158 freighters of 794,963 gross tons and 64 oil tankers of 450,263 gross tons. Only a small portion of the output consists of passenger ships, and these are for coastwise service or for use on inland waterways.

As shown in Tables I and II, which give the number, tonnage and horsepower of both merchant and naval vessels built by American shipbuilders in 1916, and corresponding figures for the work now under construction or contracted for, it will be seen that the largest output of merchant tonnage in 1916 was from the Union Iron Works, San Francisco, Cal., while nearly an equal amount was produced on the Great Lakes by the American Shipbuilding Company. Of the shipbuilders on the Atlantic coast the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., produced the largest amount of merchant tonnage.

Considering the work now on hand, it is seen that again the Union Iron Works leads with the greatest volume of merchant tonnage under construction, with the New York Shipbuilding Company, Camden, N. J., second. A noteworthy feature of these returns is the fact that not only are the old established yards filled practically to capacity, but also many of the newly established yards have a volume of tonnage booked equal to, if not greater than, the normal output of the older yards in previous years.

Concurrent with this report there has been published in the annual report of the Commissioner of Navigation, Department of Commerce, figures covering the output of American shipyards for the fiscal year ending June 30, 1916. According to this report 937 vessels of 325,413 gross tons were built and officially documented in the United States, compared with 1,157 vessels of 225,122 gross tons for the previous year. These figures cover only the vessels built and put into commission during the year, and by no means indicate the remarkable activity in all American shipyards, which began late in the calendar year 1915 and steadily increased well into the current fiscal

TABLE 1.—MERCHANT CONSTRUCTION

SHIPS BUILT IN 1916

	No.	Gross Tons	H. P.
Union Iron Works	9	65,293	24,400
American Shipbuilding Company	19	64,000	25,200
Newport News Shipbuilding & Dry Dock Company	7	51,737	20,300
Great Lakes Engineering Works	14	35,214	19,175
Wm. Cramp & Sons Ship and Engine Building Company	7	34,996	16,800
Fore River Shipbuilding Corporation	5	33,082	15,300
Bethlehem Steel Company (Maryland)	8	31,952	18,400
New York Shipbuilding Company	9	27,474	10,150
Harlan & Hollingsworth Corporation	5	18,835	20,434
Moore & Scott Iron Works	2	14,200	4,800
American Bridge Company	31	12,129	....
Toledo Shipbuilding Company	6	11,820	1,920
Skinner & Eddy Shipbuilding Corporation	2	11,460	5,000
Chester Shipbuilding Company	2	11,000	....
Baltimore Dry Dock & Shipbuilding Co	4	10,603	4,500
American Car & Foundry Company	25	10,567	....
Kelly-Spear Company	6	4,035	....
Seattle Construction & Dry Dock Co	1	4,000	2,500
Wilmington Iron Works	2	4,000	1,400
Mathews Shipbuilding Company	3	2,921	1,940
Peterson Shipbuilding Company	3	2,800	....
St. Helens Shipbuilding Company	3	2,783	1,040
Kruse & Banks	2	2,450	2,200
Manitowoc Shipbuilding Company	6	2,324	3,400
M. M. Davis & Son	5	2,250	1,025
E. J. Tull	4	1,940	45
Wilson Bros. Shipyard	2	1,920	1,700
G. G. Deering Co.	1	1,891	....
Percy & Small	2	1,620	....
Staten Island Shipbuilding Company	5	1,511	2,350
Tank Shipbuilding Company	3	1,257	....
Howard Shipyards Company	3	1,225	1,075
John Wilson Shipbuilding Company	5	1,110	210
Bean Shipbuilding Company	1	1,100	360
McKie Shipbuilding Company	1	922	1,600
Barbare Bros.	14	814	1,400
Arthur D. Story	4	738	400
Francis Cobb Company	1	578	800
F. S. Bowker & Sons	1	565	....
Sawyer Bros.	1	435	....
Bath Iron Works	3	399	8,500
Townsend Marine Railway & Construction Company	2	280	420
Dubuque Boat & Boiler Works	3	234	105
W. F. Stone	4	220	282
W. & A. Fletcher Company	1	210	600
William H. Baldwin	2	197	40
Cowles Shipyard Company	2	70	125
Mathis Yacht Building Company	8	....	....
John H. Mathis Company	4	....	....

MERCHANT VESSELS NOW UNDER CONSTRUCTION

	No.	Gross Tons	H. P.
Union Iron Works	26	177,128	73,600
New York Shipbuilding Company	17	104,501	46,650
Newport News Shipbuilding & Dry Dock Company	13	94,529	33,100
Bethlehem Steel Company (Maryland)	15	93,007	35,950
American Shipbuilding Company	28	92,900	36,900
Pennsylvania Shipbuilding Company	10	92,000	....
Chester Shipbuilding Company	14	71,500	....
Fore River Shipbuilding Company	10	66,544	30,400
J. F. Duthie & Co.	7	61,600	17,500
Willamette Iron Works and Northwest Steel Company	7	61,600	....
Harlan & Hollingsworth Corporation	13	60,744	33,830
Standard Shipbuilding Company	8	58,400	20,000
Great Lakes Engineering Works	12	54,150	19,900
Wm. Cramp & Sons Ship and Engine Building Company	8	53,810	36,000
Skinner & Eddy Shipbuilding Corporation	9	53,580	22,500
Columbia River Shipbuilding Corporation	6	52,800	15,000
Seattle Construction & Dry Dock Co	10	49,850	27,500
American Bridge Company	92	47,616	....
Tank Shipbuilding Company	27	47,500	....
Moore & Scott Iron Works	5	45,300	12,200
Texas Company	4	40,000	....
Baltimore Dry Dock & Shipbuilding Co	9	29,745	12,700
Toledo Shipbuilding Company	7	19,250	9,500
Manitowoc Shipbuilding Company	9	16,856	8,980
Pusey & Jones Company	13	13,300	....
Staten Island Shipbuilding Company	6	12,600	....
Gray's Harbor Shipbuilding Company	5	12,500	3,500
McEachern Ship Company	6	10,200	3,360
Washington Shipping Corporation	4	10,000	1,920
Palmer Shipbuilding Company	4	10,000	....
M. M. Davis & Son	8	9,900	....
Brunswick Marine Construction Corp	5	9,550	....
American Car & Foundry Company	10	8,892	....
St. Helens Shipbuilding Company	4	6,200	2,240
Coastwise Shipbuilding Company	6	5,820	....
Columbia Engineering Works	5	4,950	2,400
Peterson Shipbuilding Company	4	4,700	1,250
Bean Shipbuilding Company	3	4,000	....
W. F. Stone	2	3,600	2,000
Mathews Shipbuilding Company	2	3,600	1,280
Hanlon Dry Dock & Shipbuilding Co	1	3,500	....
Kelly-Spear Company	2	3,204	....
Atlantic Coast Company	2	3,200	....
Merrill-Stevens Company	6	3,175	1,800
Percy & Small	2	3,000	300
Kruse & Banks	3	2,400	2,000
Francis Cobb Company	3	2,340	....
Tampa Foundry & Machine Company	1	2,000	1,000
Spedden Shipbuilding Company	5	1,645	3,650
W. & A. Fletcher Company	2	1,612	6,400
G. G. Deering Company	1	1,600	....
Peninsula Shipbuilding Company	2	1,600	....
Sandifer-Clarkson Shipbuilding Company	1	1,600	480
Georgia Shipbuilding Company	1	1,350	....
G. A. Gilchrist	1	1,200	....
Sharpstown Marine Railways Company	1	1,150	....
Hillyer, Spearing & Dunn	1	1,100	....
Dubuque Boat & Boiler Works	2	1,070	200
Townsend Marine Railway & Construction Company	1	1,000	....
Bath Iron Works	1	910	8,400
E. J. Tull	1	900	....
Howard Shipyards Company	3	800	925
Arthur D. Story	3	765	1,150
Brunswick Shipbuilding Company	1	750	....
B. P. Lanteri	1	739	300
F. S. Bowker & Sons	1	550	....
Sawyer Bros.	1	500	....
Jas. Rees & Sons Company	1	460	....
William H. Baldwin	1	101	....
Cowles Shipyard Company	1	95	350
Barbare Bros.	30	....	1,500
John Wilson Shipbuilding Company	32	....	....

TABLE II.—NAVAL CONSTRUCTION

VESSELS BUILT IN 1916

Newport News Shipbuilding & Dry Dock Company	1	31,400	32,400
Fore River Shipbuilding Corporation	10	7,160	51,000
Wm. Cramp & Sons Ship and Engine Building Company	3	3,290	54,000
Bath Iron Works	1	1,075	16,000

NAVAL VESSELS NOW UNDER CONSTRUCTION

Newport News Shipbuilding & Dry Dock Company	3	97,200	102,000
New York Shipbuilding Company	2	32,640	35,000
Fore River Shipbuilding Corporation	21	16,630	224,000
Seattle Construction & Dry Dock Co	5	9,935	20,000
Bath Iron Works	6	6,776	132,800
Lake Torpedo Boat Company	8	4,400	....
California Shipbuilding Company	6	4,190	1,300
Wm. Cramp & Sons Ship and Engine Building Company	2	2,250	37,000

year. The activity is more clearly shown by the figures in Table I which cover the work up to the end of the calendar year 1916.

On July 1, 1916, there were building or under contract to be built in the United States 385 steel vessels of 1,225,784 gross tons, of which 195 of 1,037,103 gross tons were ocean steamers, each of 1,000 gross tons or over. In British yards on the same date 432 steel steamers of 1,538,640 gross tons were under construction, but the rate of progress in such construction was much reduced. The effect of this reduced output from British yards is evident when it is remembered that while at the beginning of the calendar year 1915, 1,627,316 gross tons were under construction in British yards, yet only 650,919 gross tons were launched from British yards during the year. Since late in the spring of this year, however, British shipyards have been engaged more actively in the work on unfinished merchant ships, more than doubling the output of the earlier months.

Although the total construction of merchant vessels by American shipbuilders for the fiscal year ending June 30, 1916, as reported by the Bureau of Navigation is not large, nevertheless the tonnage of ocean-going steel steamers is the largest recorded, and it is particularly to be noted that virtually half the year's product is already engaged in foreign trade. American registered steel steamers in the competitive foreign trade have increased from 1,262,159 gross tons in 1915 to 1,498,587 gross tons on June 30, 1916, a gain of nearly 20 percent against a gain of about 100 percent under the more favorable conditions of the previous fiscal year. While many vessels formerly engaged in domestic commerce have been placed in foreign trade, little has been done to replace these vessels in American domestic service, consequently it is probable that the demand for such vessels will be felt by American shipbuilders long before the present shipbuilding boom is over, and in this way the period of activity in American yards will be prolonged as the present capacity of the yards is practically booked for at least two years to come.

As matters now stand, American shipping in foreign trade has more than doubled in the last two years—a

growth without precedent in the history of any maritime nation. According to the Bureau of Navigation, the increase has been in one form of employment of American ships rather than in the total shipping under the American flag. During the past two years the total American shiping has increased only 540,961 gross tons, while American shipping in foreign trade alone has increased 1,115,563 gross tons. Whether this change in the employment of American shipping will be permanent is largely a matter of conjecture, but the immediate effect of the change can only be an increased demand for new tonnage by American shipowners for both domestic and foreign trade.

Shipbuilding on Puget Sound

The Skinner & Eddy Corporation of Seattle has a building programme which includes twenty ships. Three of these are tankers for the Standard Oil Company which are being built under the Isherwood patent. The other seventeen are cargo carriers of the general plan described on page 431 of our September issue. Seven of these ships have been sold to B. Stolt Nielsen, two having been already delivered.

The first of these, the *Niels Nielsen,* met with an accident on her first trip while under charter to Mitsui & Co. en route to Vladivostok. When about 400 miles out from Cape Flattery one blade broke off her propeller. Captain Dietrickson thought it would be safer to return to port. He ran into a storm the second day and the strain was so great that about a hundred miles from Flattery the other three blades were stripped. A wireless call brought the tug *Goliah* from Seattle, which picked the *Nielsen* up after she had drifted within sight of the breakers on Vancouver Island.

The *Nielsen* was towed to Victoria, where she was surveyed by divers at the Esquimalt shipyard. A wood box was built to fit around the stern, and after this had been fitted and pumped out a new wheel was put on. The first survey was made December 3 and the job was completed and the ship put to sea on the morning of December 12. The building of the cofferdam saved unloading the cargo.

The propeller was designed by Captain Dyson, of the American Screw Propeller Company. It was 16 feet 8 inches diameter, with a little over 14 feet pitch. The turbine that drives it develops 2,500 horsepower. The blades all broke close to the hub and one of them showed evidences of cooling strain which semi-steel is apt to have.

The *Hannah Nielsen,* sister ship to the *Niels Nielsen,* has been chartered by Andrew Wier & Co. for a period of six months at 35 shillings. Since the charter includes the proviso that the ship shall not be sent to European waters the rate is more out of the usual. The normal rate for such charters is about 3½ shillings.

The method of handling material used at the Skinner-Eddy plant is being adopted at the other yards in the course of construction, and the naval constructor at the United States navy yard at Bremerton is considering installing it there. It consists of a trolley run on a cable suspended between posts at each end of the ways. There are three of these cables, one over the centerline and one at each side. They are served by thirty horsepower drum electric winches. The masts are well anchored and the strain on the cable does not make a noticeable sag. Two trolleys are generally used, and with the centerline trolley and one of the side trolleys material can be laid down on any part of the ship.

The Seattle yards are finding this system as efficient for handling material as other systems and much cheaper to install than overhead cranes or locomotive or gantry cranes on built-up tracks. They need not interfere with sheds where sheds are built over the ways, and the sheds can be built much lighter than when they are used as support to traveling cranes.

The Seattle Construction & Dry Dock Company is enlarging its machine, boiler and blacksmith shops and installing a system of overhead trolleys to handle material over the machinery. The big shed that was built to cover the battleship *Nebraska* has been taken down, and for the present at least work will be in the open. The pole trolley system for handling material over the ways has been installed. There are six working ways at present and two more are under construction.

At present there are about 2,500 men employed, but as soon as work is started on the scout cruiser which they recently contracted to deliver to the United States government in thirty months this number will be increased to more than 3,200.

J. F. Duthie & Co. is one of the recently organized shipbuilding companies that are establishing new yards in Seattle. This company has contracts for seven steel freighters for Norwegian interests and is building a permanent plant on the East Waterway. They will employ about 1,500 men when the yard is finished and work on the ships begins, which will be about the first of January. They have constructed three building ways. They will not establish a machine shop or boiler shop at present, but will buy their boilers from the Commercial Boiler Works, of Seattle, and the turbines with which their ships will be powered will be bought in the East.

C. D. Bowles is the president of this new company, and J. F. Duthie is vice-president and general manager. The ships for which they have contracts will be freighters of the spar deck, raised forecastle, bridge and poop deck type. They will be 423 feet long overall, 54 feet beam, 29 feet 9 inches deep, 10½ knots speed and have a cargo capacity of 8,800 tons.

The Ames Shipbuilding & Dry Dock Company is building a new plant on the West Waterway in Seattle. They have contracts for three steel freighters about the same size and type as those of the Duthie yard. This yard will also enter the engine and ship repair business and they will build an 8,000-ton dry dock as part of their equipment. They will have three building ways.

The officers of this company are Edgar Ames, president; David Hollywood, general manager; George W. Albin, secretary, and J. V. Patterson, formerly with the Seattle Construction & Dry Dock Company, consulting engineer.

Captain John L. Anderson has secured contracts for two 8,800-ton freighters and will increase the size of his plant, near Kirkland on Lake Washington. The completion of the government locks between Puget Sound and Lake Washington make possible the development of this yard, which has been used to build boats for the lake service.

The Washington Shipping Corporation has four 252-foot four-masted wood auxiliary schooners on the ways, and their present building schedule calls for eight more. Their first ship will be launched in the next thirty days.

All yards on Puget Sound are finding steel deliveries slow and expensive. The sudden increase in shipbuilding has made a shortage in all lines of supplies. The shipbuilders are fighting an increase in freight rates, as the increased tariffs which have been filed by the carriers of the Northwest will put them out of business. Henry W. Thurtell, examiner of the Interstate Commerce Commission, held a hearing in Portland December 12. The present rate on structural steel is 65 cents (2/8½) a hundredweight, and the new tariff is 75 cents (3/1½).

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Trouble with Air Pump on Jet Condenser

Air pumps, as a rule, do not give much trouble and require little care. Only once have I experienced real trouble on an imitation Edwards pump in a stationary power plant. The pump was independent steam-driven and connected to a jet condenser. It had a flat piston, Fig. 2, in place of the conical piston, Fig. 1, of the Edwards pump, and this I think was mostly responsible for our trouble, the breaking of the pump rod. The flat end of the piston hit the water on the downward stroke with a loud report and only by throttling the suction valve, which in turn lowered the vacuum, could this be reduced.

This pump may have given fairly good service in connection with a surface condenser, to remove condensate and air only, but it did not in connection with the jet condenser. In fact, I believe that no Edwards pump should be used with a jet condenser, because the inrushing water interferes with the action of the pump. But the Edwards pump has all the merits of a good surface condenser air pump and may well leave the jet condenser to other types of pumps.

As a marine engineer, I don't care for jet condensers, and I could discover no reason why in this particular plant a jet condenser was installed. There was ample room for a surface condenser and the fresh water found on the property was no good for boiler feeding and was almost as expensive as city water.

After several bronze pump rods snapped off within a short time, a nickel steel rod was used with good results; that means the rod did not break during the time I was employed there, and I had no opportunity to examine the pump to find the effect of galvanic action due to the salt cooling water.

A, B. C (Fig. 1) is a good rod packing for Edwards pumps. *A* is a flat packing ring of any not too soft packing. Material *B* is a white metal ring with a number of grooves in the bore. This ring should be in one piece and as high as possible, leaving room only for two soft packing rings *C*. These hemp or cotton packing rings should occasionally be soaked in hot tallow with graphite. Very little oil should be used with any packing on this rod, because the oil will be drawn into the pump very soon. With this packing, keep a little fresh water on top of the gland. This will help filling the water grooves in ring *B*, and if the water disappears too soon, tighten up a little on your gland.

D is ordinary cord coated with white lead; lay it on the flange as in Fig. 3. It is good and cheap packing for the pump head and the head valve plate.

Newport News, Va. H. G. KLUNDER.

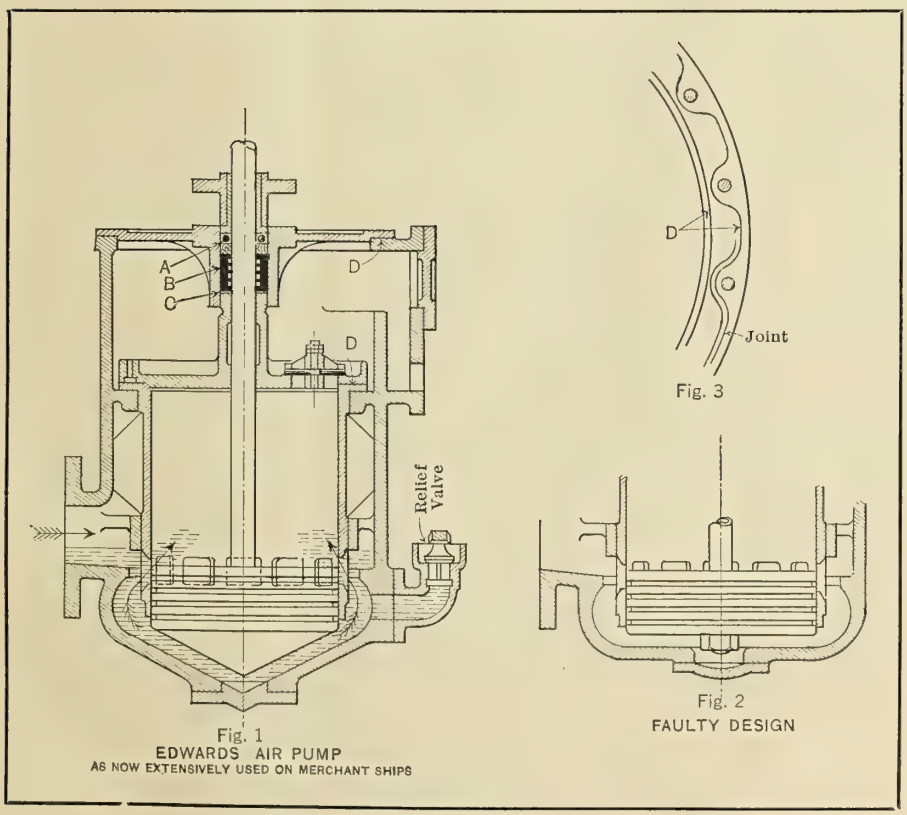


Fig. 1
EDWARDS AIR PUMP
AS NOW EXTENSIVELY USED ON MERCHANT SHIPS

Fig. 3

Fig. 2
FAULTY DESIGN

Sections of Air Pumps, Showing Cause of Failure

A Visitor's Comment

After reading N. G. Near's article, "A Poor Combination," in the December issue, page 554, I am tempted also to give a personal opinion. I feel that after the kind of courtesy given by the engineers of the boat that he inspected he shows poor thanks in criticising the chief and assistant.

He is no doubt a stationary engineer, and does not take into consideration that marine engines are not secured to bed rock foundations and that a noisy marine engine is not always a symbol of slackness in the care of it. Even after a thorough overhaul and refitting of all moving parts, the first trip that the boat makes in heavy weather (or should she happen to bump the dock a few times at either end of a trip) will develop a pound or two in some of the bearings.

Another thing, marine engines of steamboats that take people on their vacation trips are generally pretty busy and refitting bearings is accomplished in between trips, and not always a first class job can be done. The owners generally demand to keep her a-going. Perhaps N. G. Near expected that the engineer of the watch would stop the engine, take the bearings apart and show him where and what

caused the knock. Should a visitor show cheek enough to ask where the knock was in an engine of my plant, I would tell him the same thing, "In there."

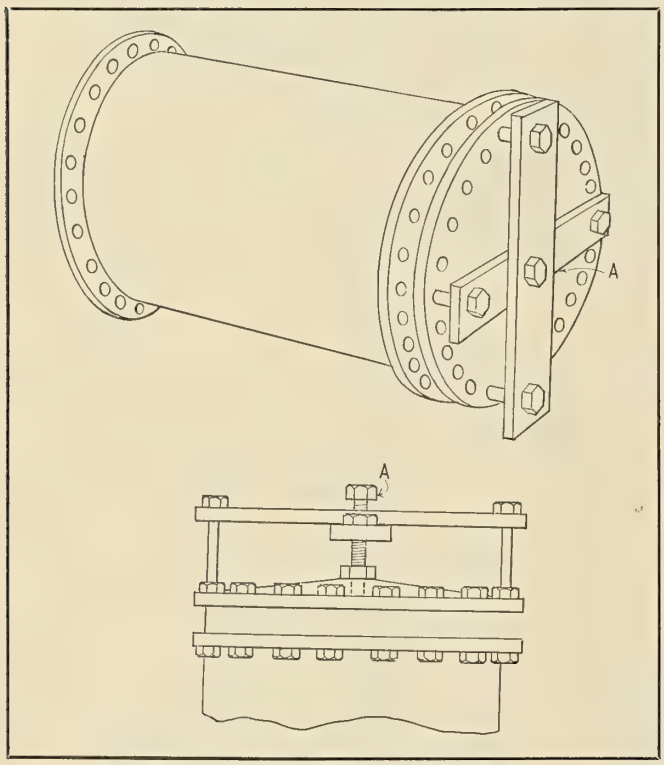
N. G. Near says that the assistant leans too heavy on the chief, and that he knew but little, as he could not answer some of the simplest questions. If he considers that talks on the relative efficiency of the engine and why the owners did not install turbines in place of reciprocating engine are simple questions, then he himself must be well educated. I think that the first assistant realized that he had an extra inquisitive visitor and that he shut him off with short answers.

Criticisms like that of N. G. Near are no doubt the reason that more visitors of his type are not welcomed into the engineers' department of a steamboat.

C. H. W.

Staying a Feed Water Heater

Constant trouble was caused by the movement of one of the heads of our low pressure feed heater. It would pulsate like a diaphragm with every stroke of the lift



Remedy for Leaky Head of Feed Water Heater

pump when the pressure got over 25 pounds, and even with a pump governor this would happen.

This pulsating of the head caused it to leak at the joint and around the bolt heads. To remedy this, I used two pieces of 1½-inch by 3-inch steel stock (in the manner shown in the illustration), taking out four bolts and putting in four longer ones to hold the straps, drilling and tapping a hole through their center for a 1¾-inch bolt.

Setting this up against the center of the head cured the trouble.

W.

Care of Marine Boilers

Boilers are the most expensive and perishable parts of the machinery of a steamship, often requiring to be replaced twice, and sometimes three times, during the life of a vessel. Deterioration and decay begin as soon as the boilers are put in use, and are only partially prevented by care on the part of designers and engineers. At the present time the demand for large and fast steamships necessitates the use of boilers of great size and cost. The attention of builders and owners is therefor directed to keeping this portion of the machinery up to the highest point of utility for the longest period at the least expense.

Twenty years ago eight years' work was considered a good average for a marine boiler, but the period of usefulness has been increased about 100 percent in recent years. This gain is due in a measure to the improved design and construction; but more probably to the more intelligent care bestowed upon them by modern engineers.

The first and simplest thing to guard against is external corrosion. This arises from various causes, drips from leaky decks, leaky screw staybolts, leaky handhole plates, joints, stuffing boxes, etc., and from a cause so apparent that it would not be noted if it did not occur so often, namely, the neglect to waterproof portions of the boilers directly under hatch openings.

There is no good reason for the existence of any of these causes of corrosion, yet they do exist and create a constant demand for the "soft patch." The most serious point of external corrosion is the front of the ash pit and the adjacent portion of the boiler head. The use of fire tools, wetting down of ashes and other causes conspire to render corrosion at this point very rapid.

It may be counteracted in part by the persistent use on the ash pit fronts of the waste oil and grease from the engine room. A better method of protecting this part of the boiler, though seldom applied, is to fit soft patches or wearing plates of 5/16-inch iron over the seams connecting the furnace to front head, and extending over the lower part of the front head to take in the front seam of the shell. This should be done when the boiler is new, and, although these wearing plates will last only a few years in active service, their renewal is simple and inexpensive; therefore, to be strongly recommended. Four years' wear in hard service has been obtained from the wearing patches by keeping them smeared with the waste oils from the engine room.

With ordinary intelligence bestowed upon the care of marine boilers, there is no reason why their period of usefulness should be shortened by external decay. Internal decay is a much more serious matter. The chief causes of trouble inside boilers are use of dirty water, greasy water, cold feed water, imperfect circulation and contracted water spaces. Using steam at a pressure of 160 pounds per square inch involves difficulties that did not exist at 75 pounds per square inch. At the latter pressure a little supplementary feed from the salt water inside of the condenser would give a coating of lime inside the boiler, prevent pitting and the oil coming with the feed water would rapidly rise in the slightly brined water to the surface and could be cared for by the scum valve, but while a sixteenth of an inch scale on a back tube plate would not cause trouble at a working pressure of 75 pounds per square inch, at 160 pounds another condition of affairs exists. The tube plates having been thickened for increased temperature, the tube ends will leak from a very slight deposit on the tube plate.

A spray from a leaky tube end, wetting the particles of ash, coal and dust carried by the draft, forms a deposit on the other tube ends and the furnace is rendered useless. If two furnaces are common to one chamber, both are disabled; much disagreeable labor is entailed expanding leaky tubes, and this must be done repeatedly until there is an opportunity to thoroughly clean the boilers.

There is also danger under forced combustion of the tube ends leaking enough to cause a back draft from the furnace into the fire room.

Corrugated furnace crowns are seriously injured by even thin scale, and it will be found that corrugations near the middle of the grate suffer most. At this point the repeated opening of the furnace doors and consequent change of temperature causes the scale to crack, a new coating is formed, is again cracked, and so on repeatedly until, in some cases which have come under the author's observation, the scale for twenty days' run had formed in leaves attached to corrugations like the leaves of a book to the binding with the open edges of the leaves, about one inch over all, toward the front of the furnace, and the attached edges about ⅛ inch thick toward the back. This shows that the evaporation is much greater at this part of the boiler. In parts of the boiler where less active generation of steam takes place, pitting is sure to follow. The under sides of boiler tubes suffer most, also the sides of furnaces about the line of the grate bars, and sides and bottom of combustion chamber. The pitting in these places is rapid and frequently unobserved in the earlier stages, the pitted parts being covered with black, moderately hard oxide, which, being removed by thorough washing and scraping, discloses the true condition of the metal attacked.

To prevent this overheating and pitting, from the presence of oil or grease, many remedies have been used with varying results. Filters of various kinds are among the most successful devices, sometimes applied on the suction side and sometimes on the discharge side of the feed pumps. These filters are of various metals; sponges, blankets, coke, charcoal, gunnysacks, horsehair, tan bark, hay, etc., each being strenuously advocated by its particular selling agent, but the results depend more upon the care and judgment exercised by the engineer than upon the material of which the filter is made.

The filter which presents the greatest surface in a given space, which can be readily replaced, and the material for which can be obtained at any port at small cost, will commend itself to engineers; but a filter tank filled with ideal material will mechanically trap only a small percentage of grease if the fitering material is not frequently cleaned or renewed.

The designer of a filtering tank should bear in mind that the location, accessibility and facility with which covers and interiors can be removed and replaced is of vital importance.

Efforts have been made to catch the grease in the main engine exhaust pipes, hoping thereby to keep the condenser as well as the boilers clean, but reports are conflicting as to the success of these devices. Feed water heating arrangements assist materially in getting rid of the grease. Cold feed water is injurious to boiler shells, furnaces and furnace seams, and feed water should be heated to within a few degrees of the steam temperature before being discharged into the boiler; but while this is generally done, it is, strange to say, not a universal practice. Heating the feed water by direct contact with steam is so simple and satisfactory that it seems to meet all requirements.

Efforts have been made to neutralize the effects of oil in boilers by injecting sal soda, caustic soda, lime water and potash with the feed water; but, as the best cylinder oils now in use are pure mineral oil and do not saponify, the results have not been satisfactory.

Zinc slabs in parts of the boiler showing decay seems to retard it somewhat, though a large quantity, sometimes amounting to tons, has been used without satisfactory results.

It will be found that boilers fed by an independent feed pump with feed water from a surface condenser, aided by an evaporator, filter and heater, have very little tendency to pit below the line of the grate bars when an efficient system of mechanical circulation is maintained. The use of hydrokineter warms the water in lower parts of boilers when getting steam, but constant circulation is necessary, especially under banked fires, and the water should be pumped continually from lower front end of boiler to upper back end.

The value of this simple method is greatly underestimated, and on many vessels the pumps are not fitted up for the purpose. Constant circulation by pumping prevents the lower shell seams being strained by unequal expansion and reduces pitting below the grate line to a minimum. The benefit derived from constant circulation below the grate level seems apparent when we consider how little pitting takes place between the grate line and top of combustion chamber. In two-furnace boilers pitting below the grate line is greatly in excess of that in three-furnace boilers, a difference due to the better circulation maintained in the latter by the location of the middle furnace.

If tubes are placed too close together, cleaning is difficult and tubes are liable to be burned at the back ends from an insufficient supply of water to tube plates. Tubes placed to give 50 percent water surface to tube plate give practically no trouble, but if placed to give only 40 percent are likely to make the water in boilers foam and give needless trouble to keep back ends of tubes tight in top sheets.

When the tubes are overcrowded in boiler various methods are resorted to, such as ferrules and cements, to prevent leaking of tube ends. However, all such devices are merely temporizing with the difficulty, which exists primarily in the defective design.

On the flame side of the furnace decay takes place at the point of contact with the brick wall, and as the deterioration covers a large surface it is apt to escape detection until the plate is quite thin. By placing thin sheet iron between the bricks and the furnace plate each time the bridge wall is rebuilt the decay may be retarded. Around the manhole joint in the interior surface of the plate pitting occurs partly from the presence of sulphur in the rubber gaskets and partly from rapid buckling upon the surface of the plates.

The wear of boilers depends much upon the character of the service in which the vessel is employed. Tug boats, bay steamers and coasters, in the order named, seem to suffer more than ocean steamers. Irregular application of heat, lying under banked fires for long periods and irregularity of washing out boilers will account in a great degree for this difference

The care of a marine boiler when not steaming is of great importance. If empty, it should be quite dry. If it contains water it should be quite full and have no leaks. Sudden stopping of engines, without an independent air pump to care for the steam, is a constant source of injury to boilers, as it is difficult to check the pressure without notice. There is, of course, no difficulty with independent air pumps to care for the steam.

The use of forced draft has added to the difficulty of caring for boilers, especially with the closed fireroom system, as the admission of cold air when the fire doors are open is the worst possible treatment for back connections and tubes. The induced-draft system is little, if any, better, either with the fan or the jet in the smokestack. The alternate high and low temperature from the immense heat of the fires and the inrush of cold air when the fires are replenished demand a very elastic duty from materials and conditions that are the reverse. Forced draft with the closed ash pit system affords better control of the steam-making power and depends less upon the trim of ventilators or direction of the wind, especially in the tropics, where fireroom duty is always severe. It is also free from the great objection of admitting a rush of cold

air when the fires are replenished. The main objection to its use is increased length of fireroom required with the ordinary type of marine boiler, but its use in moderation is extending and all the appliances to supply it are of the most permanent and durable character.

This system does away with the difficulties arising from handling coal from different bunkers and discharging ashes which are encountered with a closed fireroom, and the longest voyages may be made with a regularity of steaming impossible with a closed fireroom or natural draft.

The foregoing remarks apply particularly to the ordinary type of marine boiler, but of late years the demand for high pressure and less weight per horsepower has brought into use various forms of watertube boilers, the care of which is important. All that has been said as to the necessity of supplying pure water is more imperative with the watertube boiler than with the older type. Being more flexible, the watertube boiler suffers less from forced draft with closed fireroom, but, being more susceptible to change of temperature and having a small storage of water, will suffer greater loss from a steam-making standpoint than if used with the closed ash-pit system.

The life of grates, bridge walls, furnace fronts, depends almost entirely upon the coal used. With Pacific Coast, Australian, Japanese, Chilean and the lower grades of English and Scotch coals, the furnace fittings wear well, the linings of the fronts suffering most when the fire is too near the front. With good grades of Welsh and Pennsylvania coal the wear is much greater, especially if dampers are used suddenly to prevent blowing off steam when it is necessary to stop the engine quickly.

The most used grate bars are the thinnest, and wrought iron is preferable, as this can easily be straightened or pieced out aboard ship, when cast iron ones might not be obtainable.

Breechings, front connections and doors require constant attention when lignite or flancing coal is used, and if not kept in repair add to the consumption of coal and interfere with the draft. With patching and repairing, front connections, doors and uptakes will usually last as long as the boilers; not so with the smokestack. In active service, ten years is a long life, and this again depends on the quality of coal used. If flaming coal is used the smokestack has a very short life—not more than five years with some of the lignites.

The outside of the smokestack is protected by paint, but as yet we know of nothing that would afford real protection to the interior. Some vessels are provided with hoods to protect the smokestack when laid up, but these are seldom used when the vessel is in commission.

It is the custom of recent years to cover the greater part of boiler shells with non-conducting material, covering this in turn with either sheet lead, galvanized sheet iron or painted canvas. If either of these waterproof coverings are permitted to leak the non-conducting material, being porous, absorbs the moisture and causes corrosion. There are numerous non-conducting coverings which, when properly put on and kept waterproof, which is seldom, will last as long as the boiler.

Bottom and surface blow-off valves and feed check valves require constant attention. The scour from the blow-off is particularly bad on the seats of the blow-off valves, and if neglected and permitted to leak entail serious trouble with blow-off pipes. These valves should be ground in or faced up frequently. In using the blow-off at sea, the gradual and the simultaneous closing of outboard and inboard valves will greatly reduce wear on pipes. In these pipes the dynamic effect of the sudden change from cold water to hot pressure and the reverse is very great and will sometimes split the heaviest pipes.

The gage cocks must of necessity be blown through to keep them free, and if the composition contains zinc they last but a short time. The author has renewed them after but three months' wear, when the keys looked more like sponge than metal.

Boilers well designed, constructed of the best materials and equipped with the most approved fittings may be a source of constant annoyance and expense for the lack of intelligent care in the matter of raising steam and blowing off the water. If boilers and pipes are slowly and equally warmed before pressure is raised a most fruitful source of leakage is avoided.

When at the end of a voyage steam pressure is blown off, dampers and doors should be closed and the water left in the boilers to cool gradually, a couple of days if practical, before being pumped out. Attention to these details will be well repaid by the absence of leaks, which are inevitable when boilers are blown out with steam pressure.

The length of time a boiler may be used varies so much under different conditions that it is difficult to arrive at a satisfactory average. The author can recall two sets of boilers of the same type and in similar service, one set of which was renewed after eleven years of service. These boilers were steam tight, and from the furnace side were apparently as good as ever. Yet the back connection sheets were found to have been reduced in thickness by decay from three-quarters of an inch to barely one-half an inch. Where decayed, the combustion chamber had only about a two-inch space between that and the shell.

The other set of boilers, having 3½-inch to 4-inch water space around combustion chamber, was found to have worn very little at these points, and was continued in use four years longer.

Another marked instance has come under the author's observation where the machinery of two vessels on the same service shows marked difference in wear. The boilers in one vessel required renewal after seven years of service, while in the other they have now been running sixteen years and appear to be good for many years more. In the latter case the same chief engineer has had charge of the machinery from the beginning of service.

Among the many old boilers which the author has seen repaired he has found that as a rule comparatively little decay has taken place above the bridge walls, and the shells were pretty good except the lower parts, but the furnace lower back connection and lower stays often made me wonder how it was possible for the parts to hang together and stand the pressure test.

With the superior quality of steel available for the construction of boilers at the present time drilled holes, improved workmanship and the use of corrugated and other elastic furnaces, the life of boilers are much longer than some years ago. Evenly distributed bracing, tube space not crowded, the use of hot filtered feed water and mechanical circulation of water in boilers, with the renewal of tubes, etc., have prolonged the life of marine boilers to nearly twenty-five years as a general thing.

Eternal vigilance is the price of safety in the case of steam boilers, and the engineer who despises small things will be continually beset with small troubles, which in the aggregate will greatly reduce the period of service of boilers and engines. EDWARD B. FRASER.

MONTHLY SHIPBUILDING RETURNS.—November, 1916, was the record month for American shipbuilding, according to returns of the Bureau of Navigation, Department of Commerce. During this month, American yards completed 90,636 gross tons, all officially numbered for the American flag except two steamships of 7,847 gross tons for Norwegian owners.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Calorific Value of California Crude Oil

Q.—What is the calorific value of California crude oil as used for boiler fuel? Is it better than Texas oil? O. F.

A.—California crude oil runs about 18,500 B. T. U. It varies from the different fields from about 18,300 to 18,700. Beaumont crude has a little higher calorific value; 19,000 to 19,500, and a slightly less specific gravity.

Mechanical Efficiency and Fuel Consumption of Small Gasoline (Petrol) Engines

Q.—What are reasonable mechanical efficiencies and fuel consumptions for a four-cycle gasoline (petrol) engine of about 25 brake horsepower and for a two-cycle engine of 12 brake horsepower? M. C.

A.—For the four-cycle engine 85 percent and .6 pound of gasoline (petrol) per brake horsepower are reasonable, and for the two-cycle engine about 80 percent and .9 pound of gasoline (petrol) per brake horsepower per hour.

Calculations for Hydraulic Punch

Q.—Please give me some information through your valuable column of "Questions and Answers" of the latest hydraulic punching bars, with diagrams, if possible, and kindly work out for me the thickness of cylinder and its diameter, the length of the different internal and external levers and the diameter of ram. I must point out that the maximum diameter of punch and thickness of plate are ⅞ inch and ¾ inch respectively.

How much is counted the shearing force for punching per square inch? Of course it will be much greater than the shearing force used for ordinary calculations.

Is there any really valuable book you could point out to me dealing with strength of materials and having practical examples of daily use worked out? M. C.

A.—The resistance to punching is commonly considered as 1.7 times the theoretical resistance to perfect shear; this results for this case in the following expression:

$$P = W \pi d t$$

where P = maximum resistance to be overcome,
W = 1.7 × shearing strength (for mild steel plates and shapes 1.7 × 50,000 = 85,000),
d = diameter of hole in inches,
t = thickness of plate in inches.

For a diameter of ⅞ inch and thickness of ¾ inch this results in a force of $P = 85{,}000 \times \pi \times ⅞ \times ¾ = 175{,}000$ pounds; with allowances for friction this might be taken as 200,000 pounds.

A ram cylinder of 5-inch diameter would be about right for this case; then the maximum pressure in cylinder will be

$$\frac{200{,}000}{\frac{\pi \times (5)^2}{4}} = 1{,}020 \text{ pounds per square inch.}$$

For thick, hollow cylinders Merriman quotes the following formula to estimate thickness required:

$$t = \frac{r \times p}{f_t - p}$$

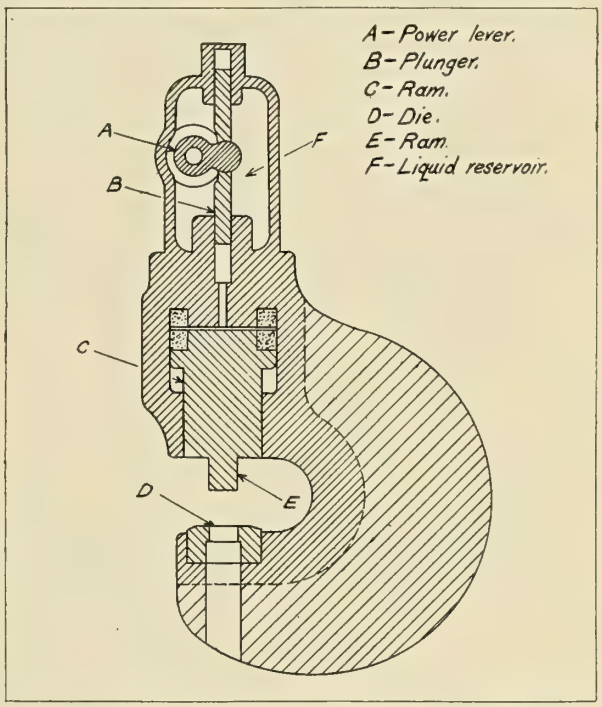
t = thickness in inches,
r = radius to inside of cylinder,
p = pressure in pounds per square inch,
f_t = working strength of material used.

For cast iron f_t = 3,000 is a reasonable value, and using this

$$t = \frac{2.5 \times 1{,}018}{3{,}000 - 1{,}018} = 1.285,$$

or a little over 1¼ inches.

The stroke should be from two to three times the thickness.



Section of Hydraulic Punch

Using a stroke of 2.5 inches, the piston displacement of ram is

$$\frac{2.5 \times \pi \times 25}{4} = 49.2 \text{ cubic inches.}$$

Assuming a diameter of pump plunger of ⅝ inch and a stroke of 3 inches, the maximum pressure on the plunger is .307 × 1,018 = 312 pounds, and the number of double strokes for 1 inch of travel is

$$\frac{49.2}{2.5 \times 3 \times .307} = 21.3.$$

Assume point of application on piston 3 inches from fulcrum, 30-inch lever; then force necessary at end of pump handle is

$$\frac{3}{30} \times 312 = 31.2 \text{ pounds maximum.}$$

Valves, passages, springs, etc., and their design are governed by good practice, rather than by fixed rules.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Sufficient space must be left in head for more than maximum amount of liquid necessary. This is to cover leakage, to provide a liquid "head" on suction valve, and to prevent air leakage below piston.

Below is given a diagrammatic sectionalized figure to facilitate following the computations.

Unwin's "Machine Design," Part I, is excellent for strength of materials and fundamental design conceptions. It has not very many illustrative examples, however.

Effect of Change to Valve Gear

Q.—What will be the effect on the valve action of a steam engine if the eccentric has a small turning taken off its face to true it up? V. G.

A.—The same effect as shortening the valve stem by the amount of the chip taken off. The eccentricity remains the same, therefore the travel of the valve, but the valve will be bodily displaced toward the crank by the amount of the cut.

Propeller Problem

Q.—What sized propeller should I put on a vessel which is to make 13 knots, on a shaft horsepower of 1,200 with the main engine turning at 150 revolutions per minute? K. T.

A.—The question has insufficient data to permit of the determination of the best propeller, but *a* propeller which would do the work provided cavitation were not encountered is: Diameter, 10 feet; pitch, 10.63 feet; number of blades, 3; projected area, 19.1 square feet; developed area, 23.2 square feet.

Specific Heat of Water

Q.—Does the specific heat of water change apreciably at higher temperatures and pressures? E. T. P.

A.—At 60 degrees F. and atmospheric pressure it is unity. At the following temperatures and pressures it has increasing values:

T	*P*	*Specific Heat*
300	67	1.029
350	135	1.045
400	247	1.064
440	381	1.082

Lubricating Oils

Q.—Can you give any suggestion or references that will be helpful to me in the selection of lubricating oils? I have a meager technical equipment consisting of hydrometer, viscosimeter and flash point determining apparatus, and have to purchase considerable quantities of lubricating oils for a rather wide range of machines. L. O.

A.—Prof. A. H. Gill, in the "Mechanical Engineer's Handbook," makes the following statement:

"In choosing a lubricant, the following points should be considered: (1) The pressure on the moving surfaces, (2) the velocity with which the surfaces are moving, and (3) their temperature. The cardinal principle underlying all lubrication is to *use the least viscous oil that will stay in place and do the work.* Besides this, the following will aid in the selection of a suitable lubricant:

"1. The flash point should be above 300 degrees F.

"2. The result of an evaporation test should be under 5 percent.

"3. For light pressures and high speeds, mineral oils (of specific gravity 30.5 degrees Bé., flash point 360 degrees F.), sperm, olive and rape oils may be used.

"4. For ordinary machinery, mineral oils (of specific gravity 27-29 degrees Bé., flash point 400-450 degrees F.), lard, whale, neatsfoot, and tallow or heavy vegetable oils may be employed.

"5. For cylinder oils, mineral oils (of specific gravity 27 degrees Bé., flash point 550 degrees F.), alone or with small percentages of animal or vegetable oils (degras, tallow, linseed, cottonseed and blown rape) may be used.

"6. For watches and fine machinery, clarified sperm, jaw and "melon" oils may be employed.

"7. For very heavy pressure and slow speed, lard, tallow and other greases, either by themselves or mixed with graphite and soapstone."

Baume Scale

Q.—Why does a higher value on the Baumé scale for specific gravity mean a lower actual specific gravity? C. H.

A.—The floating tube which serves as a hydrometer has a scale arbitrarily divided to read increasing values as the immersion increases, so that the lighter liquids (specific gravity is less) permit it to sink deeper and therefore read to a higher value. It should be noted, however, that it is only when the hydrometer is used for liquids heavier than water that the readings increase as the immersion decreases.

The instrument frequently has, however, a double scale, so that it may be used for liquids of specific gravity greater or less than unity. The scale is so graduated that the readings will increase with *increasing* immersion for liquids lighter than water, and increase with *decreasing* immersion for liquids heavier than water. For liquids heavier than water:

$$\text{Specific gravity} = \frac{145}{(145 - \text{degrees Baumé})}$$

For liquids lighter than water:

$$\text{Specific gravity} = \frac{140}{(130 + \text{degrees Baumé})}$$

Net Tonnage of Engine Room

Q.—In measuring the propelling space deductions for registered tonnage, how is the net tonnage of the actual engine room obtained? Any space occupied by and necessary for the safe working of machinery not used in propelling the ship is not to be included in the net tonnage of actual engine room. It generally happens, however, that the room necessary for the safe working of such machinery is also necessary for the working of machinery which is used in connection with the propulsion of the ship, such as the air and feed pumps. Also it is probable that piping connected with machinery necessary for the propulsion of the vessel may be over and perhaps also under spaces occupied by, say, electric light engine and dynamo. Again, if machinery not used in propelling the ship were placed elsewhere than in the engine room, a larger propelling space deduction might be obtained. Is a surveyor justified in excluding from the deduction the space right up to the "crown" of the engine room over machinery not used for propelling the ship? C. O.

A.—The rule reads that when the tonnage of the actual engine room amounts to between 13 and 20 percent of gross tonnage in screw steamers the deduction allowed for propelling power shall be 32 percent of the gross tonnage. Should the actual engine room be under or over the above percentages of gross tonnage, the deduction for propelling power may be estimated at 1¾ times the tonnage of the *actual engine room* in screw steamers.

This means that the entire volume of the engine room is to be measured and used in determining the deduction from gross tonnage of the ship to obtain net tonnage. There is no such thing as net tonnage of the engine room. It has a certain actual tonnage (its actual volume in cubic feet divided by 100) and this comprises the volume occupied by the whole propelling plant clear across the ship. If machinery necessary for the safe operation of a vessel occupies a space, and that space cannot be made available for the carrying of cargo, it should be counted a part of the machinery space; air and feed pumps should be so counted. No deduction is usually made for piping. If machinery not used in propelling the ship were placed elsewhere than in the engine room and it were possible to carry cargo in the surrounding space, the surveyor is justified in refusing to include it in the deduction.

Basically, all spaces which are not available for cargo should be deducted from the gross tonnage to obtain the net tonnage; actually, the rules vary in different countries and are hampered by numerous specific limitations intended to minimize the surveyor's discretion in deciding.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Progress of American Shipbuilding

Steel merchant vessels building or under contract to be built in private American yards on December 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 400 of 1,428,003 gross tons. On December 1, 1915, builders' returns of construction or contracts for the construction of steel merchant vessels aggregated 202 vessels of 761,511 gross tons. The tonnage building or ordered on December 1, 1916, however, is less (17 vessels of 51,943 gross tons), than on November 1, 1916, the first break in the line of increases since the issue of these monthly returns began in February, 1916.

During November, American yards finished 22 vessels of 68,922 gross tons which had been carried in these statements, and made new contracts for 7 steel merchant vessels of 18,285 gross tons.

During the current fiscal year the builders expect to launch 294 vessels of 904,231 gross tons, and during the fiscal year ending June 30, 1918, 106 vessels of 523,772 gross tons. These dates of launching, of course, are subject to the usual allowances for delays.

Shipbuilding Contracts

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Navy Department, Washington, D. C. to build two battleships to cost about $11,000,000 each.

The Newport News Shipbuilding and Dry Dock Company, Newport News, Va., will also build two battleships for the Navy Department, each to cost about $11,000,000. The displacement of all four of these ships is to be 32,500 tons each.

The Fore River Shipbuilding Corporation, Quincy, Mass., will build eight destroyers for the United States Navy.

The Union Iron Works Company, San Francisco, Cal., will build six destroyers.

The Bath Iron Works, Bath, Me., received a contract from the Navy Department some time ago to build four of the twenty destroyers authorized, and it has not yet been determined whether the remaining two destroyers will be built by contract or at the navy yard.

It is understood that the three battleships to be contracted for in 1918 will be of 40,000 tons displacement each and capable to making 23 to 24 knots.

The California Shipbuilding Company, Long Beach, Cal., will build three submarines for the Navy Department.

The Electric Boat Company, 11 Pine street, New York, will build eighteen coast and one 850-ton fleet submarines.

The Lake Torpedo Boat Company, Bridgeport, Conn., will build six coast and one 850-ton submarines.

The Portsmouth, N. H., Navy Yard will also build an 850-ton submarine.

The Seattle Construction and Dry Dock Company, Seattle, Wash., will build a 35-knot scout cruiser for the United States Navy, to cost $4,975,000. This company was the only private concern to bid on the four scout crusiers whose figure was within the appropriation of $5,000,000 each. It is stated that the Secretary of the Navy will seek an additional appropriation at the next session of Congress for the remaining three vessels. In the mantime, new advertisements for bids for the three vessels will be published by the Navy Department.

The Texas Company, Bath, Me., will build four oil tank steamers for the Texas Steamship Company, 17 Battery place, New York, in addition to the four ships, contracts for which have already been announced.

The Navy Department, Washington, D. C., is advertising for bids for the construction of an ammunition ship. Bids will be opened on January 3.

The J. F. Duthie Shipbuilding Company, Seattle, Wash., has received a contract from Norwegian interests to build another 8,800-ton steel steamship, making the seventh vessel now under contract.

The Great Northern Railway Company, St. Paul, Minn., announces that it will have four steamers built for its freight and passenger service between Seattle and the Orient. It is probable that these ships will cost about $3,000,000 each.

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Atlantic Refining Company, Philadelphia, Pa., to build two oil tank steamers, to be propelled by geared turbines. This is in addition to the six steamers for which the Union Iron Works has already received contracts from the Atlantic Refining Company.

The Matthews Shipbuilding Company, Hoquiam, Wash., has received a contract from the Hart-Wood Lumber Manufacturing Company, Hoquiam, to build a steam schooner, to cost $200,000. The vessel will be an oil burner.

J. M. Somerville, Gulfport, Miss., is having a four-masted wooden schooner built to have a capacity of 800,000 feet of lumber.

I. L. Snow, of Rockland, Me., is building a four-masted auxiliary wooden schooner for the Atlantic Maritime Company.

It is reported that the Alpha Engine and Machine Works, Portland, Ore., has a contract from Danish owners to build four steamships at a total cost of more than $2,000,000.

The city of San Pedro, Cal., will hold an election to vote on $1,000,000 in bonds to build a dry dock and shipyard. Write to Mayor F. T. Woodman.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Atlantic Gulf and West Indies Steamship Lines, New York, for two 3,000-ton steamships, to be delivered in September and October, 1917.

The Alabama-New Orleans Transportation Company, New Orleans, La., has received a contract from the Mexican Petroleum Corporation, New York, to build four steel tank vessels for the Tampico and New Orleans trade.

The Navy Department, Washington, D. C., has opened bids for the construction of four battle cruisers. Bids were received from the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.; the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.; the Union Iron Works Company, San Francisco, Cal., and the Fore River Shipbuilding Corporation, Quincy, Mass. All of the bids were based upon the cost of construction, plus a percentage of profits.

The Oregon Shipbuilding Company, Portland, Ore., has received a contract from Hannevig & Johnsen, New York, to build four 8,000-ton steel freight steamships.

The Coastwise Shipbuilding Company, Baltimore, Md., has received a contract to build two 3,000-ton five-masted motor schooners for the Baltimore and Chilean ore trade.

The Coastwise Shipbuilding Company is building two 1,500-ton three-masted wooden barges for the Cook-Cummer Company, Baltimore. The plans for these vessels were drawn by M. C. Furstenau, 308 Walnut street, Philadelphia, Pa.

The Seaborn Shipbuilding Company, Tacoma, Wash., has received a contract to build a 226-foot auxiliary schooner for Norwegian owners.

The Aberdeen Shipyard, Aberdeen, Wash., has received a contract from W. R. Grace & Company, Hanover Square, New York, to build two motor ships. The Aberdeen Shipyard also has a contract to build an auxiliary schooner for Norwegian owners.

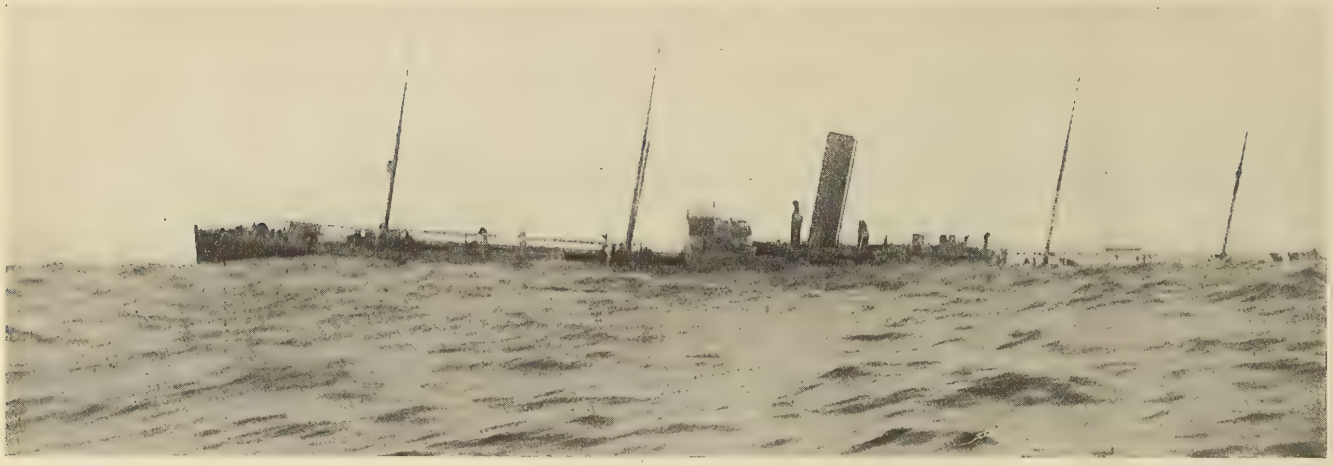
The Columbia Engineering Works, Portland, Ore., has re-received a contract to build a 266-foot auxiliary schooner for build an auxiliary schooner. This is in addition to the three orders already reported.

Barbare Bros., Tacoma, Wash., have received a contract to build eleven fishing schooners, at a reported cost of $55,000 each.

The American Dredge Building and Construction Company, Seattle, Wash., has contracts to build three gold dredges.

The Navy Yard, Mare Island, Cal., will build two torpedo boat destroyers of the twenty authorized by the last Congress.

Harry Piaggio, Gulfport, Miss., has given an order for four wooden oil-engined vessels, each to be barkentine rigged.



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S. S. *Rowanmore*, British Steamer, on Way to Liverpool from Baltimore, Shelled and Sunk by U-boat on October 26

Shipyard Notes

Rear Admiral Harris, chief of the Bureau of Yards and Docks, Navy Department, Washington, D. C., has laid before Congress recommendations calling for the remodeling of the principal navy yards of the country and the creation of two completely equipped naval bases. The plan involves an expenditure of from $50,000,000 to $100,000,000, and provides for the equipment of at least eight navy yards for the building of war vessels.

The Navy Department has decided to spend $6,000,000 for the enlargement of the navy yards at Portsmouth, N. H.; Boston, Philadelphia, Norfolk, Charleston and Bremerton. It is planned, when these changes have been made, to build battleships at Norfolk and Philadelphia, cruisers at Boston and Bremerton, and to construct gunboats, destroyers, submarines, etc., at Portsmouth and Charleston.

James Whalen, Port Arthur, Ont., has acquired the American interests in the Western Dry Dock & Shipbuilding Company, at Port Arthur and will make large additions to the plant.

According to newspaper report, Charles W. Morse, head of the United States Steamship Company, 50 Broad street, New York, is making plans to operate a large shipbuilding plant near New London, Conn., with the intention of building eight to ten thousand-ton steel steamers. It is reported that the company has already purchased a 30-acre tract of land near New London.

It is reported that Harry G. Skinner, 1414 Continental Building, Baltimore, Md., will build a shipbuilding yard at Berkeley, Va.

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S. S. *Rowanmore* Well Awash

Deibert Bros., Elkton, Md., are reported to be planning the establishment of a plant at Havre de Grace, Md., to build barges. It is stated that they have already received contracts to build several barges.

The Ames Shipbuilding & Dry Dock Company, Seattle, Wash., is having plans drawn for a shipbuilding plant by Lee & Brinton, naval architects, Seattle. This company is said to have secured contracts and completed plans to build three steel vessels.

It is reported that the plant of the Spedden Shipbuilding Company, Baltimore, Md., has been sold to A. W. Gieske, Baltimore.

F. C. Hartley, Astoria, Ore., is at the head of a syndicate which plans the establishment of a shipbuilding plant in Seattle and which is said to have already received contracts to build four wooden ships.

The Pacific Coast Shipbuilding & Dry Dock Company, Tacoma, Wash., has been incorporated by J. H. Hyde, Tacoma, Wash, and others, with the intention of constructing a shipbuilding plant and dry dock. The capitalization is $500,000.

The Riter-Conley Manufacturing Company, Pittsburgh, Pa., which has leased the plant of the Ellicott Machine Corporation, Baltimore, Md., is enlarging the capacity of that yard and will build two steel oil tank barges.

The Texas Company, 17 Battery place, New York, will enlarge its plant at Bath, Me., and build a dry dock and machine shop.

The Todd Shipbuilding & Dry Dock Corporation has been organized in Tacoma, Wash., It is stated that 100 acres of land have been purchased in Tacoma and that work will be begun at once on a dry dock.

G. D. Eckstrom and others have established a shipyard at Los Angeles, to be known as the Los Angeles Shipbuilding Company. It is reported that the new concern already has contracts to build three large steamships.

The Hoquiam Shipbuilding Company has been organized at Hoquiam, Wash., to build wooden vessels. Frank H. Lamb is president, F. G. Foster treasurer, and W. R. Marvin manager.

The Slidell Shipbuilding Company has been organized at Slidell, La., to build auxiliary schooners, and it is reported that the company already has orders to build two such vessels.

The Connecticut Marine & Motor Appliance Company has been incorporated, with headquarters in Bridgeport, Conn., by Fred Lepan, Roger O. Foust, both of Milford, Conn., and Thurber R. Chatfield, of Waterbury.

Concrete Dock Patent Upheld in Court of Appeals

A recent decision handed down by the United States Circuit Court of Appeals (October 13, 1916), and affirming a previous decision of the District Court of Eastern Michigan, presents not only striking endorsement of the value of reinforced concrete in dock construction but also recognition of original engineering effort and the engineers' right of patent protection.

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S. S. *Arabia* Sinking After Having Been Torpedoed by U-boat While Making a Trip Through the Mediterranean

The case was the Detroit Iron & Steel Company against James D. Carey, president of the Cleveland Dock & Engineering Company, Cleveland, Ohio, which owns and exploits a patent granted for a certain type of reinforced concrete dock construction adopted in a dock built for the Detroit Iron & Steel Company.

Quotations from the court decision bring out the following points: (1) Reinforced concrete docks are a proven success. (2) Careful, intelligent design actually saved in the first instance more than 50 percent over the cost of other construction. (3) Recognition has been accorded the engineer and his rights as a patentee upheld.

Marine Terminal Improvements

The New Jersey State Board of Commerce and Navigation, Trenton, N. J., has filed plans calling for an expenditure of $7,234,545, to build a marine terminal at Bayonne, N. J. The plot upon which the proposed terminal is to stand occupies about 420 acres. Plans include dock facilities for modern freight ships and the building of hundreds of lighters and barges.

R. A. C. Smith, Commissioner of Docks, Pier A, North River, New York, has opened bids for extending piers 20 and 21, at the foot of Chambers street.

The Northern Pacific Railway Company, H. E. Stevens, St. Paul, Minn., is planning to spend about $175,000 on a 600-foot addition to its ore dock in Superior, Wis.

C. B. Hegardt, chief engineer, Portland, Ore., is planning the construction of a wharf at Hood River, Ore.

McBride & Law, Beaumont, Tex., have purchased a site on which to build a reinforced concrete wharf.

The Mullen Coal Company, Brighton Beach, Ont., plans to build a 600-foot dock.

A. F. Stewart, chief engineer of the Canadian Pacific Railway Company, Fort William, Ont., is making plans for reinforced concrete docks, to cost about $100,000.

E. D. Aasby, 143 Liberty street, New York, chief engineer of the Lehigh Valley Railroad Company, is planning extensive improvements to pier 6, Jersey City.

The Camden, N. J., Board of Harbor Commissioners is making plans for extensive development of the Camden water front. It is proposed to construct piers and wharves and to build large freight sheds. Information can be obtained from J. Spencer Smith, president of the New Jersey State Board of Commerce and Navigation, Trenton, N. J.

The City of Lake Worth, Fla., is planning extensive water front improvements, including the building of a dock system. Information can be obtained from Isham Randolph & Company, 208 South La Salle street, Chicago, Ill.

The city of New Haven, Conn., F. L. Ford, city engineer, plans a $250,000 bond issue to build a dock.

The city of Atlantic City, N. J., J. M. Hackney, city engineer, is planning to build docks and shipping terminals.

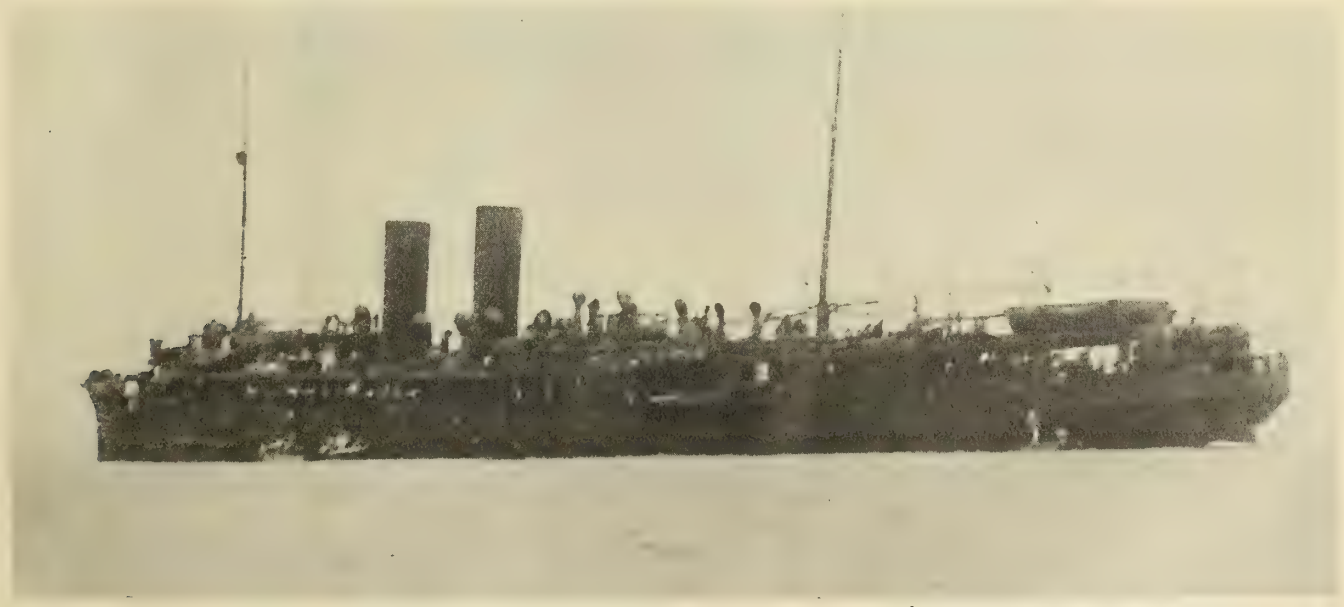
The Chester Shipbuilding Company, Chester, Pa., has given a contract to Latta & Roberts, Drexel Building, Philadelphia, Pa., to build a pier and bulkhead.

The city of Dallas, Tex., J. B. Winsnett, city clerk, has voted an issue of bonds to build a municipal wharf at Lake Charles.

The C. Reiss Coal Company, Superior, Wis., has given a contract for rebuilding and extending its ore docks at an estimated cost of $100,000.

The Canadian Pacific Railway Company, J. C. Sullivan, Winnipeg, Man., chief engineer, is planning to build docks at Vancouver, B. C., at an estimated cost of $1,500,000.

The Atlantic Coast Line Railway Company, Wilmington, N. C., and other companies are planning to spend $100,000 at Jacksonville, Fla., for dockage purposes and similar improvements.



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Passengers and Crew, Numbering 170 Persons, Leaving S. S. *Arabia* After Vessel Has Been Torpedoed by U-boat

The Frank Waterhouse Company, Central building, Seattle, Wash., is planning to spend $300,000 on a dock.

The city of Long Beach, Cal., A. de Ring, city engineer, will vote on a $500,000 bond issue, which sum it is planned to spend on piers.

John E. Matton, Waterford, N. Y., is planning drydocks and sheds to cost about $60,000.

The Axim Transportation Company has been incorporated in Louisville, Ky., by C. R. and C. C. Mengel and C. C. Mengel, Jr.

The new municipal docks at Jacksonville, Fla., comprising two piers, each 1,000 feet in length by 260 feet in width, costing $1,500,000, have been completed and are now ready for business.

The new pier, No. 7, at Cristobal, Canal Zone, which is 1,035 feet long and 212 feet wide, is nearly completed, and cargoes are now being handled at this pier.

It is reported that the Canadian Pacific Railway, Montreal, Canada, will build wharves at Vancouver, B. C., to cost $1,500,000.

The City of St. Louis, Mo., through W. T. Findly, secretary of the Board of Public Service, will build a municipal dock at North Market street to cost about $200,000.

The Bethlehem Steel Company, Sparrows Point, Md., is planning the construction of two 900-foot piers.

The Chesapeake & Ohio Railroad Company, F. I. Cabell, Richmond, Va., chief engineer, plans the construction of a pier at Norfolk to cost about $100,000.

The Minneapolis, St. Paul & Sault Ste. Marie Railroad Company, C. N. Kalk, Minneapolis, Minn., chief engineer, will build an ore dock at Superior, Wis.

The City of Ormond, Fla., G. H. Rigby, mayor, plans a bond issue to build a municipal wharf.

The State Commission of Waterways and Public Lands, Boston, Mass., has appropriated $350,000 for building docks at Fall River.

The United States Government is planning to construct a wharf at Anchorage, Alaska, to cost about $500,000.

The Chicago & Northwestern Railroad Company, Chicago, Ill., which is building a frame ore dock at Ashland, Wis., is planning the construction of another dock to be built of concrete and steel.

The Chesapeake & Ohio Railway Company, J. P. Stenem, general manager, Richmond, Va., is planning to extend piers No. 3 and 12, at a cost of about $50,000.

The Edison Electric & Illuminating Company, 39 Boylston street, Boston, Mass., has let a contract to extend its wharf and bulkhead to the W. L. Miller Company, 171 Alford street, Charleston, Mass. Cost about $40,000.

The City of Seattle, Wash., C. D. Calley, 1525 Thirty-second avenue, Seattle, bridge engineer, is planning to build a dock.

Diesel Tanker Overhauled at Newport News Shipyard

In November, 1912, the motor-driven tanker *Juno* was placed in service and she was equipped with the first high-powered reversible Diesel engine that the Werkspoor Company, of Amsterdam, built for marine purposes—this motor being of 1,100 brake horsepower (1,460 indicated horsepower at 115 revolutions per minute, with mechanical efficiency of 78 percent, and a mean effective pressure of 105 pounds per square inch), or equivalent to about 1,300 steam indicated horsepower.

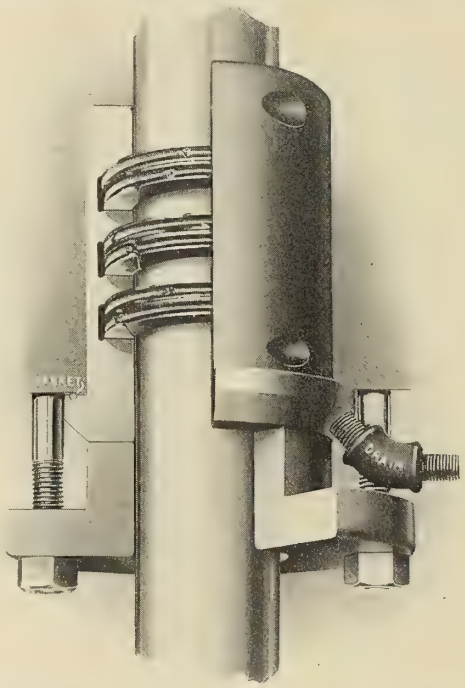
This ship has recently been docked at Newport News to have the Lloyds No. 1 Survey, which takes place at the end of four years' service. According to Mr. Charles Bailey, chief engineer of the Newport News Shipbuilding and Dry Dock Company, a thorough examination was made of the hull and machinery, but very little work on the engine was found necessary. One of the company's engineers accompanied the *Juno* to the Capes, and reported the running of the machinery as very satisfactory.

The *Juno* is of 4,300 tons displacement, and carries about 2,500 tons of cargo, on a deadweight capacity of 2,675 tons, at an average loaded speed of 9¾ knots, and with a fuel consumption of a little under 5 tons of crude oil per day. Her engine has six cylinders, 22-inch bore by 39⅜-inch stroke. Her engine room staff consists of chief, first, second and third engineers, four oilers and two cleaners. The lubricating oil consumption is about 20 gallons per 24-hour day. The vessel's length between perpendiculars is 258 feet, with 45 feet beam and 18½ feet draft, and her trial speed was 10½ knots. Her owners are the Anglo-Saxon Petroleum Company, of London.

It may be remembered that with the old design of Werkspoor-Diesel engines there was not considered enough space between the valves for cooling purposes, and about a year ago a new cylinder design was produced in which there is at least four inches of cooling water between every valve, and this was found to be so faultless that the builders were not contented with adopting it for new engines, but fitted the new design of cylinder to some of the older vessels in service. *Juno* was one of these ships, and having new cylinders, new pistons naturally were required, and the opportunity was taken to use the latest design. A section of crankshaft also was fitted. This was at the beginning of the year, since when the engine has been running splendidly, and goes to prove how necessary is seagoing experience to produce a satisfactory design of marine Diesel engine.

Martell Metallic Packing

The illustration shows a metallic packing arranged for marine service, which is manufactured by the Martell Packings Company, Elyria, Ohio. The packing rings, of cast iron or bronze, are in a split case enclosed in the stuffing-box. The regular gland is retained, but simply holds the gasket in the

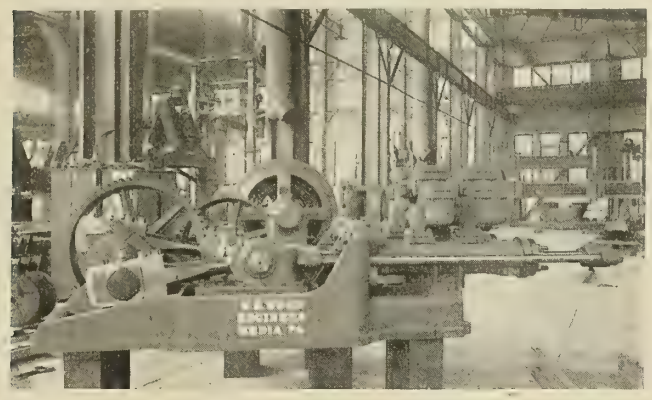


outer flange firmly against the face of the stuffing-box. Retention of the regular gland in working position seems to give the engineer a greater sense of security, although no case has ever occurred where fibrous packing had to be substituted for the metal parts. It is plain, however, that this could be done in a very few minutes if it should be necessary. The feature of the small flange intervening between the gland and the stuffing-box is unique, and has a number of advantages, the most important being that it allows the use of a properly proportioned drain pipe to take care of condensation; secondly, it brings the gasket where it is readily accessible, and there is no danger of the packing becoming fast in the stuffing-box. The fact that the manufacturers of this packing can successfully pack a 6-inch rod with but 3 inches of longitudinal or vertical space is of special interest to the marine engine designer, as the possibility of either increasing length of the connecting rod or establishing a lower center of stability in the hull is thereby made possible. In packings of this type the friction is entirely negligible, and the use of lubrication is practically eliminated.

Hydraulic Horizontal Pressure Pumps for Puget Sound Navy Yard

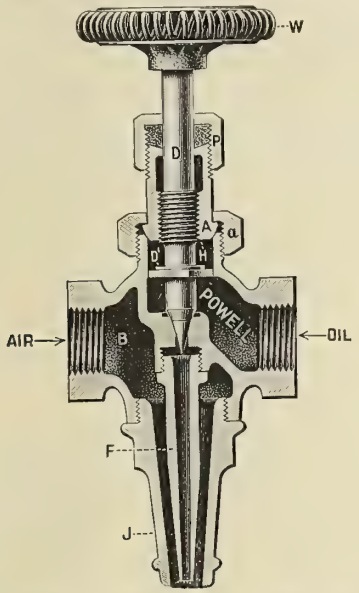
Two sets of double-acting horizontal pressure pumps with water plunger 2⅞ inches diameter by 12-inch stroke, driven by 100-horsepower electric motors, furnished by the General Electric Company, have been designed and built for installation at the Puget Sound navy yard, Washington, by William H.

Wood, Media, Delaware county, Pa. On the end of the motor shaft for driving the pumps is a rawhide pinion working through compound gearings, so as to give the pumps a capacity to deliver 75 gallons per minute against 1,800 pounds pressure, or 60 gallons per minute against 2,000 pounds pressure. These pumps are to work with one of William H. Wood's hydraulic accumulators with 16-inch plunger and 15-foot stroke.



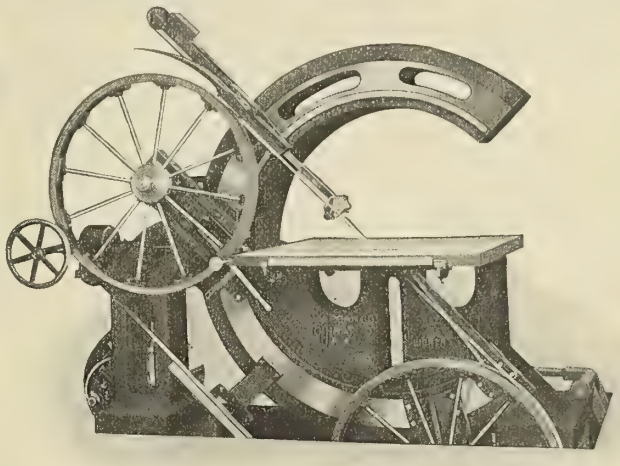
Powell Oil Burner Valve

The William Powell Company, Cincinnati, Ohio, has placed on the market the oil burner valve illustrated, which is the result of special tests for proportioning the oil tubes and air nozzle so as to produce the maximum amount of heat with a minimum amount of oil and air. The stem is machined with a needle point and fine thread, permitting a close regulation of oil. The oil tube has a long, taper point, adapted for the close control and economy of oil, while the air nozzle is of heavy construction, especially proportioned to meet the general conditions as a spray or atomizing transmitter. It is claimed that the free and unobstructed passage of the oil will not clog or interfere with the proper flow, and can be used in connection with compressed air, blowers, fan-blast or steam.



"Lightning" Band Ship Saw

The No. 311 "Lightning" band ship saw illustrated, which is manufactured by J. A. Fay & Egan Company, Cincinnati, Ohio, is designed for extra heavy band sawing, both straight and curved work. The blade can be set at any angle by power or hand while it is sawing, making the machine particularly valuable in shipbuilding work. The machine saws to any angle in a full semi-circle, the wheels being carried on a housing mounted on roller bearings and angling 45 degrees to right or left by power, with hand wheel adjustment for extremely fine setting. The angling mechanism is carried on an auxiliary column at the rear. The table measures 48 by 48 inches, and is mounted perfectly rigid on the main column, so that it is always level. The wheels are 48 inches diameter by 3 inches face, carrying blades up to 3½ inches wide. As the wheels move simultaneously, and always in the same plane, the cutting point of the blade is always at the same point on the table line regardless of the angle of the blade. Power is furnished by a 15-horsepower motor belted to the main driving pulley.



PERSONAL

C. A. MASTERS, treasurer of the Alaska Steamship Company, Seattle, Wash., has resigned to become president and managing director of the Washington Shipbuilding Company, Tacoma, Wash., recently incorporated.

ANDREW FLETCHER, president of the W. & A. Fletcher Company, Hoboken, N. J., ship and marine engine builders, has been elected president of the American Locomotive Company, New York. Mr. Fletcher is also a director of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.; president of the Consolidated Iron Works and the North River Derrick Company, and a director in several banks in Hoboken.

CHARLES P. SUMNER, dean of the transatlantic steamship agents, and for many years general agent of the Cunard Line, first in Boston and more recently in New York, retired on December 31. Mr. Sumner's successor is Mr. T. Ashley Sparks, a partner in the firm of Funch, Edye & Company, agents of the Commonwealth & Dominion Line in New York.

OBITUARY

WILLIAM C. WILLIAMSON, founder of the firm of Williamson Bros. Company (now the American Engineering Company), of Philadelphia, Pa., and originator of the steam steering gear in the United States, died in Philadelphia on December 2, aged 80.

CAPT. C. B. PARSONS, former president of the Maritime Exchange of New York, died in New York on December 22, aged 82. Captain Parsons had long been a prominent figure in marine circles. During the Civil War he served in the Engineer Corps. After the war he was in command of various vessels engaged in the coastwise and West Indian trades, retiring from the sea in the late eighties to engage in ship brokerage as partner in the firm of B. T. Betty & Company, New York.

MISSISSIPPI RIVER FREIGHT LINE.—The Kansas City-Missouri River Navigation Company, which operates a freight line on the Missouri River between St. Louis and Kansas City, handled a tonnage of over 18,000 tons inbound and outbound freight over the municipal wharf in Kansas City during the past season. This is an increase of 10 percent over the inbound freight hauled in 1915, but there was a falling off in outbound freight due to the embargo and freight congestion on Eastern lines. This winter the company is trying an experiment in hauling freight between St. Louis and New Orleans. As the equipment includes weather-proof, fireproof steel barges and towboats, high-class freight is especially solicited. No other freight line on the Mississippi River is competing for this class of freight.

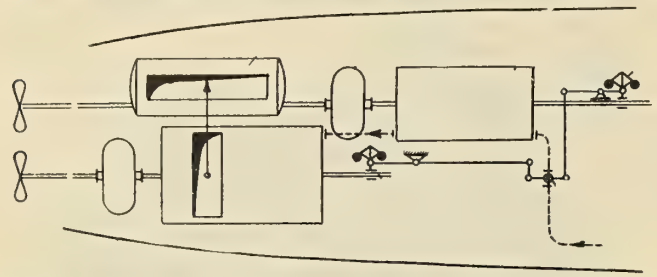
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,199,362. REGULATOR FOR POWER PLANTS. HERMANN FOTTINGER, OF ZOPPOT, NEAR DANZIG, GERMANY.

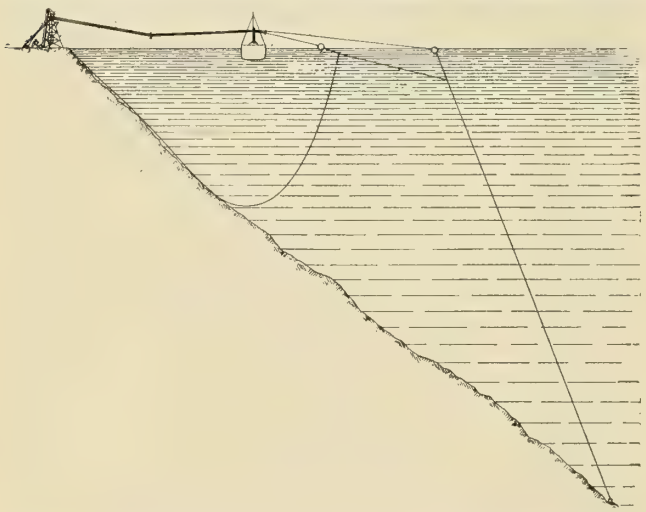
Claim 1.—The combination with a power plant including a plurality of units operating independently on successive expansions of a motive



fluid, of means automatically permitting the direct exhausting of motive fluid from the high pressure unit upon relieving the low pressure unit of load. Eleven claims.

1,187,540. CABLEWAY. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

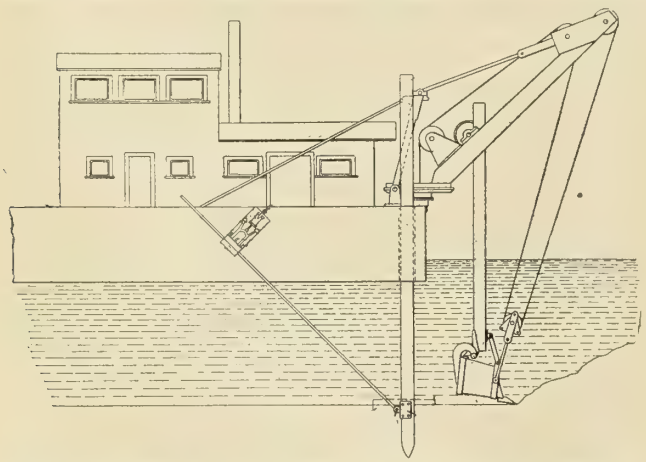
Claim 1.—In a cableway, in combination, a support, a restrained float, a cableway suspended by the said support and connected to said



float, and a floating support located between said first-named support and said float, and provided with a supporting seat upon which the cable is freely movable in the direction of its length. Fifteen claims.

1,188,899. DREDGE-SPUD BRACE. ALBERT BASIL CLARDY, OF BALBOA, CANAL ZONE.

Claim 1.—The combination with a dipper dredge and a spud connected therewith, of means connected adjacent the lower end of the



spud and extending thence upwardly and rearwardly to brace the same, and means temporarily holding the upper end of said bracing means. Four claims.

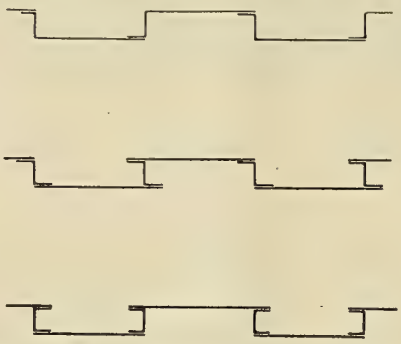
1,189,027. SOUNDER. ROBERT L. WILLIAMS, OF BOSTON, AND EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNORS TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 21.—A device comprising a floating body, a tube mounted therein open at its lower end whereby it may contain water, a rod located in said tube and supported whereby its lower end will be located in the water in said tube and its upper end be free therefrom, and means for supporting said rod comprising a watertight chamber and means located therein to engage said rod about a vibration node, and means for supporting said watertight chamber adapted to be connected to the water-free end of said tube, in combination with means located in said tube adapted to act upon the water-free end of said rod to excite vibrations in said rod. Twenty-four claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

10,577/15. "IMPROVEMENTS IN BULKHEADS FOR SHIPS." J. R. BARNETT, WESTFIELD, RALSTON AVENUE, CROOKSTON, RENFREWSHIRE, SCOTLAND, NAVAL ARCHITECT.

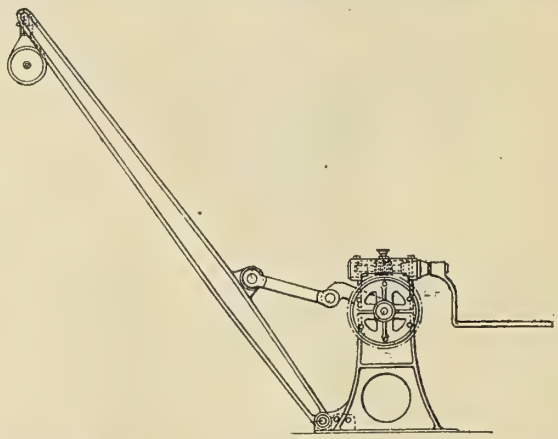
The bulkhead, instead of being built with a plating arranged in one plane, and having the stiffeners on one or both sides of the plating, is



built with the plating arranged "out and in" fashion, the amount of "out and in" being the depth required for the stiffeners. The plating may be either built vertically or hrizontally as occasion requires. The drawings indicate a few of the ways in which the construction of this type of bulkhead may be varied, namely, with flanged plates or stiffeners separate, all of any section and arrangement as required.

7,895/15. SHIPS' DAVITS. A. WELIN, OF HOPETOUN HOUSE, LLOYDS AVENUE, IN THE CITY OF LONDON.

This invention relates to improved means for luffing ships' davits of the type in which the davit is luffed by means of a link connected to it and to a rotatable crank. There is a frame in which is mounted, so that it is turned about a horizontal pivot, a davit arm. Journaled in the frame is a worm, which can be rotated by means of a crank handle and



which meshes with a worm wheel on a spindle rotatably mounted in the frame. The spindle has fast upon it an arm, the outer end of which is connected by a link to a pin on the arm. The arm is shown in its limiting position in which the pin, which forms the connection between the link and the arm, is in the plane passing through the axes of the spindle and the pin. In order to luff the arm inboard the crank handle is turned and the arm, turning clockwise, pulls upon the link and luffs the arm. Or the arm may be formed in one with a ring of teeth which mesh with a pinion on the spindle, the other parts being the same as those shown.

16,631/15. VENTILATOR COWLS FOR SHIPS. J. JENKINS, OF 5, CALEDONIA STREET, DALMUIR, IN THE COUNTY OF DUMBARTON, NORTH BRITAIN.

The invention has for its object to provide a simple down-draft ventilator cowl for ships, and having improved means for prevention of the ingress of water to the ventilating trunk upon which it is fitted. The cowl comprises in combination two rotatable coaxial cylindrical structures one within the other, segmental apertures in the structures, baffles on the structures extending into the annular space between them, louvres in the lower open end of this space, a well at the lower edge of the aperture in the inner structure, and apertures in the well giving communication with both the outside and inside of the inner structure. A perforated plate is provided on the part of the inner surface of the outer structure furthest from the aperture therein, and a series of oppositely angled vertical baffles on the front of the perforated plate. Above the louvres is a further series of louvres overlapping each other and carried by the inner structure at the lower edge of the aperture therein.

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Battle Cruiser Contracts

EVERYONE who has carefully investigated the policy of the Navy Department in embarking upon the unprecedented program of naval construction authorized by the last Congress realizes that rapidity of construction is a paramount issue in the fulfillment of its aims. No fault can be found with the various departments responsible for the design of the fifteen different types of vessels embodied in this program. Due to the unremitting efforts of the bureaus in charge of the work, plans and specifications for all of these vessels were practically completed as soon as the naval appropriation act was approved. The celerity which attended the preparation of the designs, however, is not apparent in the placing of contracts for several of the most important items in the program—that is, the battle cruisers and scout cruisers. In spite of the fact that private shipbuilders anticipated these requirements and with a commendable spirit of patriotism prepared to meet them at the sacrifice of more profitable business, they are now faced with the possibility of this work going to government yards, where neither the necessary equipment nor—what is more important—the men are available for carrying out the work. The fairness of recent offers made by private shipbuilders for meeting this national need cannot be denied, and if their co-operation in the naval policy of preparedness is valued, their proposals deserve a better reception than antagonism and suspicion.

Coastwise Shipping

NO one can regret more keenly than does MARINE ENGINEERING that the Congress of the United States saw fit to change a law which has been on the statute books for considerably over a century and open the way for foreign-built vessels to enter our coastwise trade. Let us hope the new Federal Shipping Board will realize this mistake and make it one of its first duties to request Congress to right this wrong.

Meantime, coastwise shipping companies ought to protect themselves to the fullest extent against this possible invasion. This probably cannot be done by building larger vessels, nor is it probable that a much better type of vessel can be designed than that now in general use, but when it comes to terminals there is room for much improvement. In other words, it is not in carrying the freight that economies or improvements can be made, but in the terminals of the steamship lines where the cargoes are loaded and unloaded.

Exhaustive investigations were made recently by the Interstate Commerce Commission into the subject of water-borne freight, and careful analysis of these figures shows that the cost of the carriage of freight is only 40 percent of the total, whereas the cost of handling the freight at terminals is 60 percent of the total. It is terminal costs, therefore, that our coastwise lines must turn to, to make the necessary savings.

In the December number of this magazine it was stated that there is a potential saving of between $50,000,000 (£10,250,000) and $100,000,000 (£20,500,000) by introducing efficient apparatus at marine terminals for handling freight. Just think of the material reduction in the high cost of living, if steamship and steamboat companies could effect half of this saving and divide it fifty-fifty between stockholders and freight shippers! Purely as a business proposition, it is appalling that terminal costs should be half as much again as costs of carrying the freight.

In connection with this subject of terminal costs comes another opportunity for saving as well as for increasing the efficiency of water carriage, by steamship and steamboat companies employing their own motor trucks for receiving, as well as delivering, freight. Several steamship companies are already using their own motor trucks for collecting freight as well as for delivering it, and have thereby greatly increased their traffic. There must be profit in running trucks to marine terminals or no one would be in the business. This profit is just as important to the steamship or steamboat company as it is to the shipper, or whoever owns the trucks. What every traffic manager is looking for is increased profit, and it seems to us certain that in the near future steamship and steamboat companies will find it almost neecssary to use improved freight handling machinery and also to operate their own trucks, so as to expedite the handling of freight and to make it worth while for shippers to use vessels in preference to railroads whenever possible.

Increasing Use of Watertube Boilers in Merchant Vessels

EITHER shipbuilders are finding it difficult to secure early delivery of boiler plate from the steel makers, or else shipowners are beginning to recognize the advantages of watertube boilers, for recently numerous instances have come to our notice of the adoption of watertube boilers in merchant vessels. The latter reason we hope is true, for it has been proved again and again not only that higher efficiencies can be obtained with watertube boilers, resulting in material savings in the fuel bill of a steamship as compared with a similar ship equipped with Scotch boilers, but also that watertube boilers can be relied upon for safety and durability and that they can be operated at a lower cost of maintenance and are more flexible than ordinary Scotch boilers. These facts are convincingly set forth in the admirable paper by Mr. Charles F. Bailey, chief engineer of the Newport News Shipbuilding & Dry Dock Company, presented at the International Engineering Congress, 1915. Watertube boilers provide not only increased efficiency, but also a material saving in weight and space which in these days of abnormal freight rates and scarcity of tonnage means increased profits for the additional freight that can be carried.

Refrigeration and Refrigerator Insulation on Board Ship

[COMMUNICATED]

Referring to the paper on "Refrigeration and Refrigerator Insulation on Board Ship," by Mr. Robert F. Massa, presented at the recent meeting of the Society of Naval Architects and Marine Engineers, an abstract of which was published on page 546 of your December, 1916, issue, there are several statements in the paper I would like to discuss.

USE OF SHEET CORK AS AN INSULATING MATERIAL ON BOARD SHIP

Where sheet cork is to be fitted to the ship's sides or between the overhead beams or around rivet heads of plating, the cost is prohibitive on account of the great amount of labor required to fit the cork so carefully as to avoid the air pockets which Mr. Massa very rightly states must absolutely be avoided. Furthermore, the insulation to be effective must be carried at least 1 inch or 2 inches clear of the face of the ship's beams or frames, and as this will usually require at least 8 inches of filling, I suggest a loose material which can be packed in between

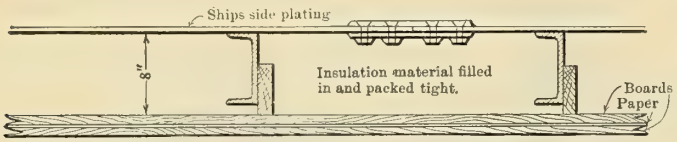


Fig. 1.—Sketch Showing How Insulated Material of a Loose Nature Can Readily Be Packed in Behind Boards to Form a Good Insulation.

the holding boards, as shown in Fig. 1. This is more satisfactory than sheet cork and also very much cheaper.

The relative cost of equal insulation between sheet cork and granulated cork when using 8 inches of the granulated as compared with 4 inches of sheet cork is in the proportion of 16 cents per square foot of insulated surface for the granulated cork and 54 cents per square foot of insulated surface for sheet cork. This does not take into consideration that in order to use the sheet cork between the beams or on the ship's sides it would be necessary either to fill in the whole 8-inch space with sheet cork, as in

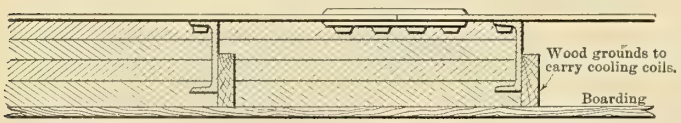


Fig. 2.—Sketch Showing Difficulty of Fitting Sheet Cork Between Frames and Over River Heads, Etc., so That it Will Be Practically Air Tight.

Fig. 2, or else to fill in between the beams and frames with 4 inches of sheet cork and build a 4-inch sheet cork box around the projecting edge of each beam and frame, as in Fig. 3. If the former method of construction (Fig. 2) is adopted, the relative cost per square foot of surface would be $1.08 per square foot for sheet cork against 16 cents for granulated cork, and would result in a smooth, straight surface, as required for fitting the pipes and to prevent hot air pockets from forming between the projecting beams and frames. If the latter method (Fig. 3) be adopted, the cost of raw material would be nearer to 54 cents for sheet cork and 16 cents for granulated per square foot insulated surface, but the cost of labor in carefully fitting the sheet cork around all the projecting beams and frames would be very large and, from a construction point of view, I would consider it an almost impossible task to make it sufficiently air tight, as suggested in Mr. Massa's paper, and as required to give beneficial results.

Where partitions between rooms have to be erected, sheet cork is undoubtedly one of the finest insulating materials which can be used because it lends itself to such

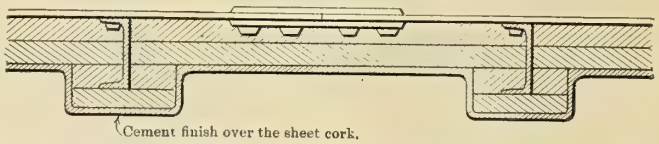


Fig. 3.—Sketch Showing Difficulty in Fitting Sheet Cork Around the Frames og a Steamer so As to Avoid Expense of Material Required to Fill Out Flush.

construction and gives the same insulating value for a less thickness, with, of course, a less waste in valuable space.

CARBONIC ACID MACHINES IN AN ENGINE ROOM

It is well known and has been thoroughly demonstrated by many hundreds of installations, both large and small, that carbonic acid machines are absolutely safe in so far as damage from escaping carbonic acid gas is concerned when placed in an engine room. The carbonic acid gas does not and cannot by escaping so contaminate the atmosphere in the engine room as to prevent the engine room staff from attending to their duties in operating the main engines, and therefore cannot jeopardize the safety of the vessel by driving the engineers from the engine room when the ship may be in a critical position.

Ammonia machines, it is well known, especially in large sizes, can become a menace to safety in this direction, but this is also well known to all people interested in marine refrigeration, whether as constructors or users, and therefore only the smallest sizes of refrigerating machines utilizing ammonia are ever placed in the engine rooms, and these are usually placed in a recess built into the top sides of the engine room so that any escape in ammonia gas from the machine would go upwards through the skylight or out through ventilators provided and cause little or no inconvenience to the operating staff.

Many of us who have had considerable experience with operating engineers, both at sea and on shore, know full well that it is not safe to form any hard and fast ideas on the merits of any particular type of machine from the engineering experience which any operating engineer may have had, as these men are particularly apt to run to extremes in their prejudices and condemn a type of machine in its entirety because one machine has given them trouble when possibly that particular machine may have been applied in an entirely wrong manner, and placed in a wrong position by some person ignorant of the correct method of handling or locating it. The small ammonia machines usually do not contain more than about 30 pounds of ammonia, and this amount is not sufficiently large to do any damage when the machines are placed as intended. This is borne out by the many hundreds of satisfactory ammonia installations so placed on shipboard.

PACKING WEAR

The mere fact that there are at least 7,500 enclosed type machines fitted with crank case packing, some of which have been in operation for over sixteen years, and none of which has had to renew the crank shaft due to wear in the packing space, is sufficient to offset Mr. Massa's remarks regarding the possibility of trouble in this direction.

Brooklyn, N. Y. LLEWELLYN WILLIAMS.

River Steamboating

An "Old Salt's" Observations on Western River Navigation

BY "OLD SCOTCH"

ANYTHING you are not accustomed to looks strange, doesn't it?

A boy brought up in a great city who is suddenly moved to a small town on the prairies expresses surprise at everything he sees, and quite likely pokes fun at the "Rubes" and everything they do.

That is because of his lack of experience and general ignorance of things beyond his immediate horizon. But the older we get the less liable we are to be surprised at new things, and the more tolerant we become of other people's methods when they differ diametrically from those to which we are accustomed. Hence on the occasion of my recent visit to places on the Ohio River, with an idea of looking into the subject of river navigation generally, I was, owing to my mature years, in a receptive attitude, prepared to learn and not to scoff.

I know it is the general tendency of all salt water men —that is, those who are accustomed only to navigational methods on seas, bays and sounds—to belittle the steamboating methods on our great inland rivers. While admitting that river steamboats, with their twin stacks, huge stern paddle wheels and cumbersome cabins, which are the same now as in the days "befo' the wah," do look odd to those unaccustomed to them, my receptive attitude put me in an investigating turn of mind, rather than one of criticism.

Stern Wheel vs. Tunnel Stern Steamers

In common with most salt water people, my first question was as to why they do not at once discard the wheelbarrow type and take up the more modern propeller type, with tunnels if necessary. That is a perfectly natural question when we consider that even the side-wheelers have practically disappeared from ocean and sound navigation, to be supplanted by the now almost universal propeller type.

Rivers such as the Ohio and Mississippi, however, present entirely different problems. Here the water is always smooth, comparatively speaking; the current always runs one way, and varies from nil to eight or nine miles an hour; the depth, which at flood times may reach as much as fifty or sixty or more feet, is for the greater part of the time comparatively shoal—indeed, in many places as low as four or five feet. The Ohio River and its tributaries, the Monongahela and Allegheny, would not be navigable at all in the summer time were it not for the work of the Federal Government in canalizing these waterways with dams placed at proper intervals to keep the depth of water sufficiently high to permit of navigation. Splendid stone locks are fitted around these dams, the majority of them not less than 600 feet long. Hence, with the current always in one direction, the problem of transporting barges loaded with coal, iron ore, etc., resolves itself into one of pushing instead of towing.

In these narrow waterways it can readily be seen that much better control is had of a fleet of barges with the towboat behind instead of in front. With six or eight large barges laden with several thousand tons of cargo, celerity of control is a very important factor in undertaking the passage of locks. This is much more readily obtained with these large stern wheels than with quickly revolving, but necessarily small, propellers. Better and more prompt steerage way is given by the two or three large balanced rudders placed immediately ahead of the paddle wheel than the arrangement of rudders aft of the propellers, as customarily fitted. True, we saw a small towboat under construction having twin screws and tunnel stern, fitted with five rudders, one in each tunnel ahead of the screws, and three aft of the propellers. That, however, is but one of the many experiments which have been conducted to supplant the now almost universal stern wheel type of propulsion. Taking into consideration the shoal water, the necessity for prompt control in negotiating the locks, and other local conditions, we must admit that it will be many days before the old-fashioned stern wheel type will be entirely supplanted.

Propelling Machinery

Granting, therefore, that for the present at least the type of propulsion can very easily be defended, we will next look at the power plant. Up to five or ten years ago coal was almost a negligible factor, in the upper waters of the Ohio at least, for that commodity could be purchased very cheaply, often as low as $2 per ton. Here I have unwittingly fallen out of the river vernacular. Nobody on the rivers ever speaks of *tons* of coal; the bushel is the prevailing unit of measurement, 80 pounds to the bushel and 25 bushels to the ton of 2,000 pounds. Always, in speaking of the relative economy of different boats, they say, "She only burns so many bushels a day." Economy of power plant with such low cost of fuel was evidently a negligible factor. Now, however, with coal from $4 to $6 a ton (excuse me! I mean 5 to 7½ cents a bushel) the operators are taking notice of economy, as the fuel bills are mounting skyward along with the cost of living.

The prevailing type of machinery consists of two horizontal engines, each with about 5 to 7 feet stroke, fitted with poppet valves, and working on a crank at each end of the paddle wheel. The connecting rods are of wood, and, as can well be imagined, are enormous in size from a salt water viewpoint. Here, too, I am getting away from the language, as these rods in river parlance are always known as Pittman's, probably from the name of some early inventor. Up to very recent times these engines were nearly all built for high pressure, the exhaust being led up the stacks, thus furnishing a very good system of forced draft, if economy of fuel is not considered. In extremely cold weather the exhausts are directed into the paddle wheels on either side to prevent the paddle buckets from becoming heavily coated with ice. Before being led to the stacks, or paddle wheel, however, each exhaust pipe is led through a large drum, mounted on top of the "doctor," thereby constituting a very efficient feed water heater.

High-Pressure Boilers

The surprising thing to me was the steam pressure carried on these boats. Nearly all that I saw carried from 200 to 250 pounds pressure on the boilers. As they cut off at about two-thirds stroke, the exhaust goes up the stack with a considerable cough, and the approach of a

river boat is easily heralded by the escaping steam, even in these days.

The steam plant usually consists of a battery of two, three, or even four of the old-fashioned "saw mill" type of boilers, externally fired with return flues, or in some cases tubes. While this type of boiler was discarded many years ago for ships in salt water, they have some advantages, principally of low height and center of gravity and their ability to handle muddy river water, which seem to commend them for this particular class of steamboats. I am not altogether prepared to state that the ordinary type of Scotch boiler, or a good marine water-tube boiler would be superior for this use, but my first impression is that they would be.

Some of the fittings they use on their boilers are, to say the least, likely to startle the average salt water marine engineer. For example, on the several vessels I visited I did not see a single water gage glass. Each boiler is fitted with but two gage cocks, but the main reliance for water height seems to be placed on a float gage placed on top of each boiler shell. A graduated sector with a pointer operated by the float through a vertical stem gives the height of the water in inches above the highest heating surface. While this apparatus would be quite unreliable on a ship rolling in a seaway, it seems to do the trick all right on these river boats, always operating in smooth water.

Disposal of Ashes

In one operation, at least, the river engineers can put it all over their sea-going brethren, and that is in the disposition of ashes. Instead of hoisting them laboriously by hand, or shooting them overboard through an ash ejector, the river steamboat fireman has an ash hopper right in the front part of the ash pan. The boats only draw two or three feet of water, hence it is very easy to fit an ash discharge pipe through the bottom of the boat, with a hopper extending two feet or so above the waterline. They do not even bother with fitting a cover over the hopper. The coal is dumped in the gangways right around the boilers, so that, except for long trips, the fireman can dispense with the services of coal passers. The holds of these steamers are only 4 or 5 feet deep and do not seem to be used for anything in particular, although I was informed that on packet steamers, when there is a rush of freight, barrels and packages are occasionally carried in the hold.

But to return to the power plants. The more modern steamers are being fitted with compound engines, some tandem and others cross-compounded—that is, the high pressure cylinder on one side and the low pressure cylinder working the crank on the opposite side. Even then they, with few exceptions, operate high pressure, as the river engineers seem to be chary of condensing apparatus. While this arrangement is, of course, not the most economical that can be devised, it is a great improvement over the single cylinder high pressure engines so largely used heretofore.

Some progress has been made with the use of triple expansion engines driving screws in tunnels, but there seems to be a consensus of opinion among those who have given the subject much thought that the screw-driven tunnel boats will never be universally adopted so long as the river conditions are as at present. It can readily be conjectured what would happen to screw propellers operating in tunnels when the boats necessarily get in shallow water, at times from 4 to 6 feet deep, with the bottom of the river containing branches of trees and other refuse.

It would seem, therefore, that the future trend of improvement in the economy of river transportation would be directed toward the development of an economical power for the driving of paddle wheels or stern wheels. By means of such improved devices as the latest link belt drives and reduction gears of various designs, it would seem that geared turbines and even Diesel engines will at no far distant date be adopted successfully. The advancing prices of coal will compel some such steps as those indicated to be taken.

The "Doctor"

No discussion of river steamboating would be complete without at least passing reference to the sacred "Doctor," as the feed pump in almost universal river use is termed. These are generally of massive construction from a salt water standpoint and consist essentially of a vertical steam cylinder driving a beam mounted on a vertical framework, which, by means of a connecting rod and crank, turns a huge fly wheel. From each side of the beam two vertical plunger pumps are driven, two for cold water from the river or tanks, discharging into the feed water heater, and two on the other side of the beam for hot water, drawing water from the feed heater and discharging the same through check valves into the boilers. The whole apparatus probably weighs four or five times as much as an ordinary vertical feed pump would to accomplish the same work, not to mention taking up about ten times as much space.

While this pump seems very crude and cumbersome to a sea-going engineer, there is much to be said in its favor. First, it is absolutely reliable, a very desirable feature for a feed pump, and, second, you are bound to get the full stroke of your pump, something which cannot be said of the ordinary type of feed pump. I do not suppose that any good river engineer would think of using any other kind of pump, as their "Doctor" certainly prevents all of the ills incident to boiler feeding. They are not pinched for weight and space, as on sea-going ships, so maybe their pet hobby is not so far wrong after all.

The Absence of Lagging

As I stated at first, it was my intention to learn rather than criticise, but there is one delinquency on the part of river designers which I cannot help criticising, and that is the almost total lack of lagging on the engine cylinders; in some instances, even, large lengths of live steam pipes were observed to be unlagged. To my economical soul this seemed almost like sacrilege. Heat units by the hundreds could be observed escaping and running around the engine room untrammeled. Luckily it was December weather, and their escape was accompanied by no physical discomforts on the part of the observer.

There is a certain air of romance about Western river steamboating, due no doubt to the writings of such eminent literary geniuses as Mark Twain, Hay and Dickens. In viewing the cabins and general fittings of these boats, one can well imagine that there has been but little change in these particulars since the days when these writers made the Mississippi River steamboats famous the world over. The huge gangplanks suspended by a derrick over the bow of the boat are the same, doubtless, as when Clemens sung out, "by the mark twain" from his lonely position as leadsman. The pilots still sound the sonorous whistle for river landings by pressing down on a lever with the foot. The same fancy work around the tops of the stacks exists to-day, as does the most fantastic scroll work in the ceilings of the cabins.

It is not generally known, but nevertheless the fact, that

our present term of "stateroom" originated from the practice of designating the sleeping rooms on these boats by the names of States, such as Maine, New Hampshire, Louisiana, etc., instead of by numbers, as at present. Then, too, I was told a very interesting thing in regard to the living quarters of the officers and crew. These are almost invariably on top of the saloon deck, put there purposely so that the men may sleep in a place as far removed from the noise as is possible. This house is known as the "Texas," following out the general plan of naming after States, the idea being that Texas was the largest State, and so on board ship the Texas is large enough to accommodate the entire crew.

A novelty which attracted our attention was a number of fancifully painted boards hung alongside the lower deckhouses of all river steamers. These boards, each about 3½ or 4 feet long, 18 inches wide and 2 inches thick and containing two small slits, large enough to insert one's hands, aroused our curiosity. When informed that they were used for quick action lifebuoys, the mystery was explained. Although they do look odd, I believe I would rather have one to hold me up in the water than some ring buoys I have seen on ocean-going vessels which have about fourteen coats of white lead paint on them.

Although the majority of the river steamers have wooden hulls, the more modern of them are being constructed of steel, and the latter material is now preferred.

Being accustomed to having vessels in salt water docked at least once, and preferably twice, in a year, we were greatly surprised to learn that, with wooden hulls in particular, they are only docked once in four or five years. There appears to be no marine growth which attaches itself to the underwater body sufficiently to necessitate more frequent dockings. As the hulls proper are relatively a small part of the structures, we were informed that it is not at all infrequent that the upper works of some steamers outlast two or three different hulls. The slow-moving engines last an indefinite time, as the wear on them is comparatively negligible. Boilers, of course, have to be renewed about as frequently as they do on salt water craft.

Much is heard as to the decadence in river transportation nowadays. While it is true that the traffic is not now so great as it was some years ago before the paralleling railroads were built, there are strong indications of a considerable revival of river commerce. Especially was this noticeable on the Monongahela River, where we were informed that the traffic has doubled in a comparatively brief space of years. Many new towboats and barges are now being constructed along the banks of that river to meet the pressing demands of coal transportation for the great steel mills and other manufacturing enterprises. Much to our surprise, we were advised of the total cessation of coal shipments from Pittsburg to New Orleans and other points on the lower Mississippi. This condition is probably due to the great local demand for the coal mines in western Pennsylvania, and to the influx of the cheaper coal from the Alabama mines, which supplies all demands in that vicinity.

There is, of course, considerable local freight and passenger business between various points on the Ohio and Mississippi. From a strictly outside point of view it would seem that there are excellent prospects of a good increase in river traffic in the near future. Water transportation must be cheaper than by rail. The introduction of modernized power plants should result in great saving in fuel cost and consequent further cheapening of water transportation. Such passenger vessels as we saw had accommodations of the very crudest type. An improvement in this respect to anything like the comfortable quarters on lake and seaboard steamers should, it would appear to an outsider, result in greatly increasing the passenger traffic between river ports. Many American travelers would be lured to take trips on river steamers on the Ohio and Mississippi, were they assured of the same comforts and conveniences that they get elsewhere.

Use of Southern Yellow Pine in Shipbuilding

Qualities Which Make Southern Yellow Pine Superior for Shipbuilding Material—Its Uses on Naval and Merchant Vessels

BY A. C. POWERS*

THE prime object of the shipbuilder is to secure material of strength as well as durability, and to comply with the conditions resulting from the calculations and specifications made by the architect or designer. For the attainment of these objects no wood has been found superior to Southern yellow pine. That this is the case is clearly indicated by the vast amount of this wood used by the best shipbuilding concerns during the past hundred years.

Southern yellow pine, comprising the families *Pinus palustris* (Longleaf pine), *Pinus herterophylla* (Cuban pine), *Pinus toeda* (Loblolly pine), and *Pinus echinate* (Shortleaf pine) is found in practically all of the Southern States. It is one of the most important and valuable woods of the world, that importance being attained from a unique combination of properties. In the first place, it possesses qualities of strength and elasticity not found in other woods. And these qualities, combined with its comparatively light weight and the ease with which it can be worked, make it a wood peculiarly adapted to ship construction.

While it is true that other woods, such as fir and spruce, have been and are still being used to a considerable extent in the shipbuilding industry, this, in the opinion of the writer, is largely due to lack of familiarity in certain quarters with the superior qualities of Southern yellow pine. Having had many years' experience in connection with working Southern yellow pine for various purposes on all classes of vessels, from the construction of an ordinary float to the laying of decks on the Government's battleships—for which latter purpose this wood is extensively used—the writer has come to the conclusion that this material is by far the most important and valuable wood used by the Government in barge and ship construction, especially for work requiring strength combined with lasting qualities. Conclusive evidence of the value and dependence the Government places on Southern yellow pine is found in the vast number of coal and freight carrying barges it builds exclusively out of this

* Timber Expert, U. S. Navy Yard, Norfolk, Va.

material. Both experiment and experience have demonstrated that this wood possesses qualities especially adaptable to such use.

As compared with Douglas fir, perhaps one of the best-known woods in the marine field, Southern yellow pine has been found to be vastly superior for deck planking and similar purposes. This is due to Southern yellow pine's much closer and finer texture, which contributes to its excellent wearing qualities. A striking example may be cited in the case of the U. S. S. *Nebraska,* built by Moran Brothers at Seattle, and completed in 1907. In pursuance of the Government's policy to encourage the use of local products in construction work, Douglas fir was permitted to be used as an experiment in laying the decks of the vessel. The result of this experiment was so unsatisfactory that the Navy Department decided to continue the use of Southern yellow pine, in accordance with standard practice, and abandoned the use of Douglas fir. In fact, only in the case of some of the more recently built battleships has any substitute for Southern yellow pine been used. Teak is now being used experimentally on ships of the superdreadnought class, but the difficulty of obtaining this wood and its consequent enormous cost may be said practically to eliminate it as a factor in competition with Southern yellow pine.

In addition to the superior wearing qualities of Southern yellow pine as compared with Douglas fir and other similar woods, it is comparatively free from the tendency to shrink and check, which are peculiarly undesirable faults of the latter, and especially objectionable in wood used for deck planking.

The United States Engineer Corps constructs practically all of the barges used in maintenance and improvement work on the Mississippi River out of Southern yellow pine, as the wood possesses the lasting qualities which make it especially adapted to such use. The timber and planking used for such purposes, however, must be selected with a view to the particular fitness of the material for the work in hand, which in this case requires Dense Southern yellow pine, formerly known as Longleaf pine.

The strength of this wood can be increased materially by the process of seasoning. If used in a green state, the timber not only is lacking in strength, but is subject to continual change in bulk, form and stability, while the effect of moisture is to cause the tubular fibres to swell; hence if a plank is wet on one side, the fibres on that side will be distended and the plank will warp or bend. It should be noted, however, that the amount of shrinkage of this wood in length, when seasoning, is so inconsiderable that it may be disregarded by the shipbuilder.

Many manufacturers in the past were of the opinion that the bleeding of Southern Longleaf yellow pine was injurious to the timber, but a special investigation conducted by the United States Department of Agriculture, Division of Forestry, involving mechanical tests as well as physical and chemical analyses of the wood from bled and unbled trees, has completely disproved this theory. As a result of the Government's experiments it has been clearly demonstrated that bled timber is as strong as unbled, while the bleeding process was attended by little or no shrinkage of the wood or change in weight; the loss of resin affecting only the sap wood, proving that the durability of the heartwood was not lessened by the extraction of the resin.

Although this wood has attained a most enviable reputation and unrivaled popularity in the marine field, it may be pointed out that great care should be exercised by the builder in selecting the timber to be used, as timber cut at the wrong season—too young or too old—is not suitable for such work. If the material is manufactured from trees cut before they have reached maturity it is deficient in the properties of strength and durability and contains a greater proportion of sapwood. If allowed to grow too long, the heart of the tree becomes either brittle or soft, impairing its durability. As it is impossible to calculate in advance the strain that may be brought to bear on the different parts of wooden vessels, only material of dependable strength and durability should be used.

The construction of war vessels and large seagoing merchant vessels out of steel has reduced in late years to a large extent the use of Southern yellow pine, as well as other woods in ship construction. A century ago Southern yellow pine was the most important of all the woods used in shipbuilding, and to-day it remains the leading wood bought by shipbuilders, meeting the demand for a variety of uses. Some of the uses to which this wood is put in ship construction are as follows:

In steel battleships Southern yellow pine is used for decks, gun foundations, plank sheer, coamings and bending strakes, etc.

In steel merchant vessels it is used for decking, rails, bulkheads, foundations, sheathing, coamings, boat chocks, interior finish, hatch covers, etc.

In wooden merchant vessels it constitutes almost the entire construction, being used for hull, frame timbers, counter timbers, cant frames, carlins, deck stringers, deck frames, spirketings, beams, clamps, anchor chocks, anchor strakes, half frames, bulkheads, covering boards, base boards, main decks, berth decks, quarter decks, rails, transoms, sheathing, ceiling, masts, mast partners, waterways, interior finish, coamings, spars, chocks, breast hooks, floor timbers, ledges, etc.

In wooden barges Southern yellow pine is used for keelsons, frames, deck beams, decking, clamps, cross braces, flash boards, rake ends, fore and aft deck stringers, bulkheads, sheathing, anchor stocks, rails and hatch covers.

Edge-grain Southern yellow pine, designated as "riftsawn" or quarter-sawn, has been used extensively by the Navy Department for decking on all classes of vessels, from the tug to the modern battleship, as this material is especially desirable for decking. The specifications admit no piece in which the angle of the grain exceeds 45 degrees, thus excluding all pieces that will sliver or shell from wear. It is particularly desirable to have material of this character for the decks of battleships, which are subject to unusual wear, owing to the large crew required to man these ships. Only wood that is hard, strong, tough, compact and durable can be used for such work.

Due to the excellent qualities of Southern yellow pine for ship construction, the demand for this wood has grown continuously, until at the present time it stands in a class by itself for such purposes; and, while the demand is already enormous, it must of necessity be much greater in the future on account of the increasing scarcity of white oak, which is the only wood used in ship construction in place of Southern yellow pine with the exception of teak, which, as before stated, is obtainable only at prohibitive prices. Shipbuilders, however, will find it much easier to secure suitable material for ship construction in the future than in the past, as the rules issued by the Southern Pine Association defining Dense Southern yellow pine eliminate coarse-grained material, which is unsatisfactory for ship construction, and admit only material that shows an average of at least six annual growth rings per inch and at least one-third summerwood, all as measured over the third, fourth and fifth inches of a radial line from the pith.

Fig. 1.—The *Prometheus* Ready to Leave Dry Dock at Mare Island Navy Yard

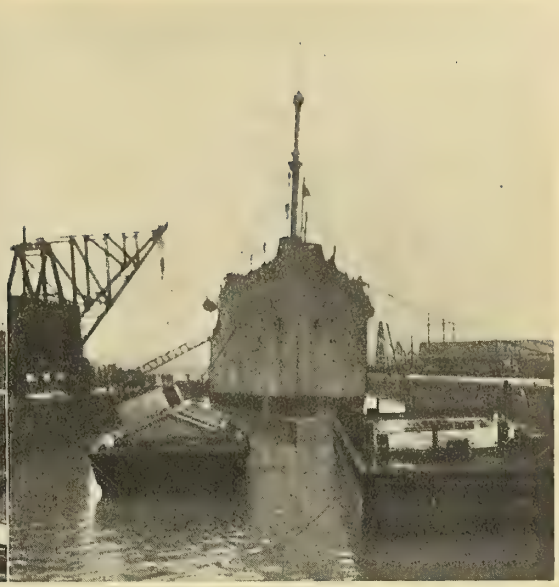


Fig. 2.—*Prometheus* Undergoing Tilting Test in Dock

Towing the United States Collier Maumee from Mare Island to New York

Naval Collier of 14,500 Tons Displacement Towed Without Mishap a Distance of 5,260 Nautical Miles in 26 Days' Steaming Time

BY FRANK A. STANLEY

WHEN the U. S. S. *Prometheus* dropped anchor at Tompkinsville, Staten Island, New York, on April 2 last, she had completed a towing undertaking the biggest on record with the exception of the towing of the dry dock *Dewey* to Cavite, P. I., some years ago. This towing project involved the bringing of the U. S. oil tanker *Maumee* from Mare Island yard, California, around through the Panama Canal to New York, a journey of 5,260 nautical miles, the actual steaming time being twenty-six days, and the total time, including a stop of nine days at the isthmus, thirty-five days.

The *Maumee* has a displacement of 14,500 tons; a cargo capacity of 7,554 tons of oil; a bunker capacity for oil fuel of 1,658 tons. She was built at Mare Island yard and simultaneously with the construction of her hull at this yard her engines of the Diesel oil type were under construction at the New York navy yard. As she was to be assigned to service with the Atlantic fleet, the Navy Department decided that instead of having her engines shipped across the continent and installed at Mare Island, it would be preferable to have the vessel towed around to New York and have her engines installed at that place.

The naval vessel *Prometheus,* under the command of Captain F. D. Karns, was selected for the towing project, and the two ships got under way on February 27, 1916, passing out through the Golden Gate on the evening of that date and arriving at the Government anchorage at Tompkinsville, exactly five weeks later.

Details of the Prometheus

The *Prometheus* is the latest of our navy's repair ships, and is really a floating shop with every mechanical department aboard which would customarily be found in a machine plant ashore. The ship has complete machine shops, iron and brass foundries, boiler and plate shop, forge shop, pipe and sheet metal shops, pattern and wood working shops, optical department, and so on, and carries an immense supply of all kinds of materials likely to be required in the handling of repairs for the different vessels in the fleet.

Her machine tool equipment alone represents an outlay of over $56,000 (£11,500), and this, with the machinery in the other mechanical departments, brings the total up to nearly $80,000 (£16,400). The tools in the machine shops range in all sizes up to capacities sufficient for the heaviest work likely to be required. The two gray iron cupolas in the foundry have capacities up to 2 tons per hour, and the forge shop has, among other equipment, a steam hydraulic forging press, of 150 tons capacity. In addition to the departments referred to there is a complete drafting office, and, further, a planning department for laying out and following through all repair work handled on board.

The normal displacement of the *Prometheus* is 12,585 tons; length over all, 465 feet 9 inches; breadth on load waterline, 60 feet 1 inch; mean draft, 26 feet. She has two vertical triple expansion engines with high pressure cylinder diameter of 28 inches; intermediate cylinder, 44½ inches; low pressure cylinder, 75 inches; length of stroke, 54 inches. The total indicated horsepower is 7,500. There are six Babcock & Wilcox watertube boilers with four doors to each furnace and with total grate surface of 493 square feet and total heating surface of 19,974 square feet. She has a bunker capacity of 1,576 tons. Her speed is rated at 16 knots.

Figs. 1 and 2, showing the ship ready to be floated out of dry dock at Mare Island, give a very satisfactory idea of her proportions. At the time when these photographs were taken the vessel had just been given her tilting tests, and Fig. 2 shows the ship inclined to port under these tests. In this inclination test the big crane shown alongside the dock was utilized for swinging aboard some very heavy weights, which were placed on a car, which was adapted to travel on a narrow gage track placed crosswise of the vessel's deck. This carload of weights was hauled by block and tackle to the side of the ship, and the inclination then measured for future reference in trimming ship when coaling or handling cargo.

After the *Prometheus* had left the navy yard dock she steamed down to the government coaling station a few miles above San Francisco, where she received the coal

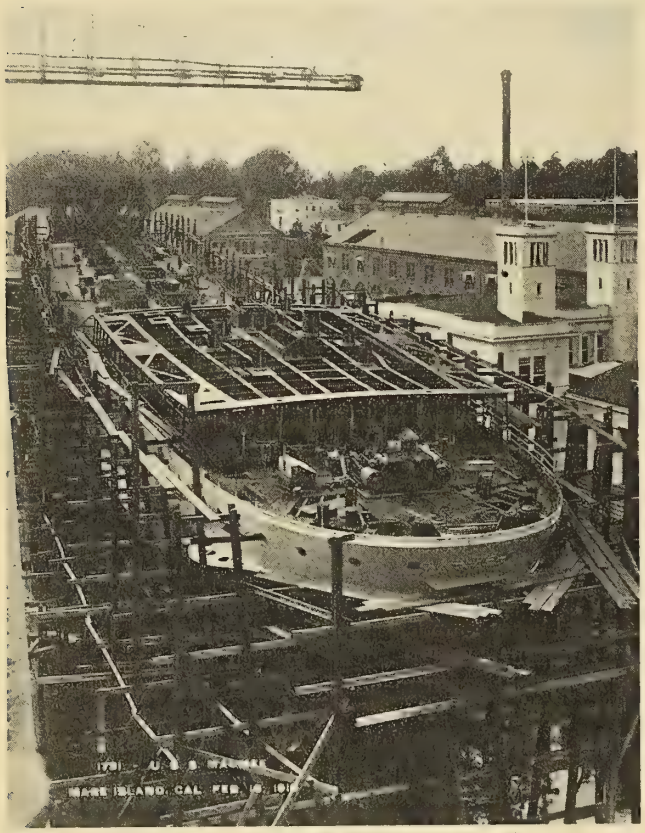


Fig. 3.—The *Maumee* in Her Building Slip at Mare Island Navy Yard

supply necessary for the voyage to Panama, the first stopping point on the schedule. At this coaling station a number of cars are operated along the top of the structure to bring in rapid succession one carload of fuel after another to the front of the station, where the coal is dumped down chutes into the ship.

The Tanker Maumee

Before taking up in detail a description of the towing operation, further brief reference to the tanker *Maumee* may be of interest. While the tonnage of this fuel supply ship has already been given, her actual size and proportions will best be gathered by inspection of Figs. 3 and 4. The first of these shows the *Maumee* approaching completion in her building slip at Mare Island, and this view conveys an accurate impression of the length and breadth of the vessel. Fig. 4, which is reproduced from a negative made while the *Maumee* was being passed through the Pedro Miguel locks at Panama, also shows the six electric locomotives which are used in the operation of taking big ships through the locks.

The *Maumee*, it may be stated, has a total length of 475 feet 7 inches, a breadth of 56 feet, a depth of hold of 33 feet 11 inches. Her mean draft loaded is 26 feet 2 inches.

For the towing of the *Maumee* the *Prometheus* had been equipped with a big towing machine and other special apparatus had been placed aboard to facilitate the carrying out of the undertaking. She was supplied with a new 7⅛-inch wire hawser (diameter 2¼ inches) of 300,000 pounds per square inch ultimate strength, and a very heavy towing arch was erected near the stern to carry the hawser clear of the ship's structure and to support it properly under all conditions of towing. This towing arch is clearly shown in Fig. 5.

From this view will be seen the very heavy proportions of the towing arch and the manner in which it was carried above the deck by stiff triangular supports, built up of steel plates and angles. This view also shows the location of the towing machine nearly fifty feet forward of the arch, the big driving gear and drum flanges being shown projecting above the top of one of the 5-inch guns on the quarter deck.

The Towing Machine

The towing machine, which was built by the American Engineering Company, of Philadelphia, Pa., is clearly illustrated on the deck of the vessel in Fig. 6. This view shows the heavy design and construction and illustrates the method of mounting the machine on the deck. The line drawings, Figs. 7 and 8, give in plan and side elevation the principal dimensions of the machine and show the method of operation.

Control of the Towing Machine

Referring to Fig. 7, the pilot valve which admits steam to the cylinders through the reverse valves is seen at *K*. This pilot valve is operated by a pin sliding in the slot in the valve stem *J*, the pin forming a part of the crank *H*, which is actuated by the segments mounted upon the same shaft as the hand lever *G*.

Steam can be admitted to the cylinders by hand by operating this lever, or this lever is operated automatically by means of the link *F*, which engages the cams 1, 2, 3 and 4. These cams are operated by a pinion *A*, which is fastened to the end of the drum shaft and meshes with the gear *B*, which is carried by the gear plate *C*.

When picking up a tow, the hawser is paid out by disconnecting the automatic gear and throwing the reverse valve lever *G* away from the drum.

After the required amount of hawser has been paid out, the machine is set for towing automatically by swinging the automatic out of gear by means of the hand lever, then the two large gears on the automatic gear plate *C* are revolved independently of each other until the cam *E*, which is controlled by the cam in the gear *D*, is completely exposed and on top. Then the reach rod *F* is dropped and the automatic gears are swung into contact with the pinion, care being taken that the cam just engages the slot in the reach rod and that the main valve is closed. The towing machine is then ready for towing automatically.

The three fixed cams 2, 3 and 4, on the disk of the automatic gear, are only used for closing the valves to a safe opening when the valve has been opened full, due to paying out more line than is required for ordinary towing. This closing to a safety opening stops the engine from racing when taking in the line under full head of steam.

Fig. 4.—The *Maumee* in Pedro Miguel Locks, Panama Canal

The cams 2 and 3 are carried by the gear plate *C*, which is rigidly connected to the cam gear *D* and rotates on a pin. It is carried by a hand lever not shown. The cams 2 and 3 are rigidly fastened to the plate *C*, but the cam 1 slides in a radial slot. It is shown in its extreme outward position. It is guided by a cam slot in the cam gear *D*, which has 43 teeth on its outer periphery. The automatic gear *B* and the automatic cam gear *D* are driven by two pinions on an extension of the drum shaft. The pinions have the same number of teeth, but one of the gears has a few less teeth than the other gear.

The proportions of the two gears and the cam slot *D* are such that in one revolution of the cam gear *D* the cam 1 will move from its extreme outward position to its extreme inward position. The cam 1 will, when out to its full extent, operate in the slot of the reach rod to open

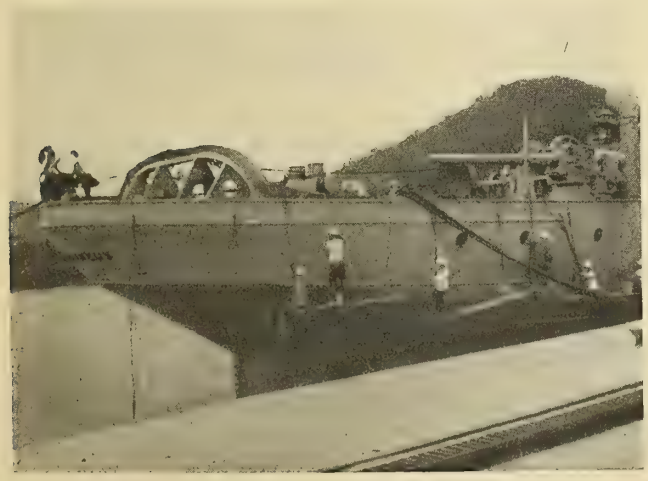


Fig. 5.—Towing Arch Over Stern of Ship. View Taken at Pedro Miguel Locks, Panama Canal

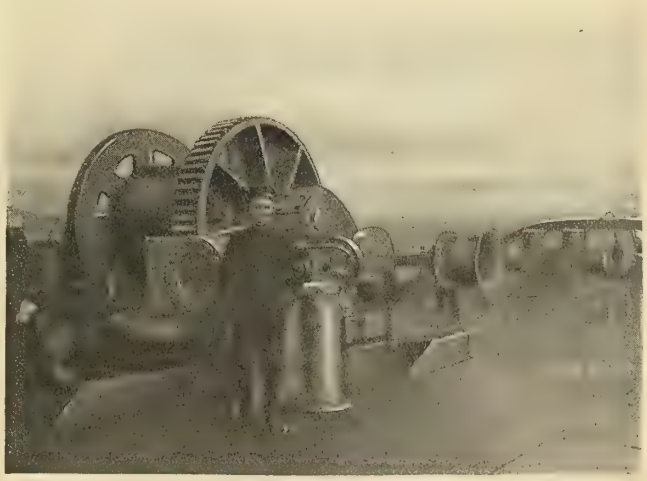


Fig. 6.—Towing Machine on After Deck of *Prometheus*

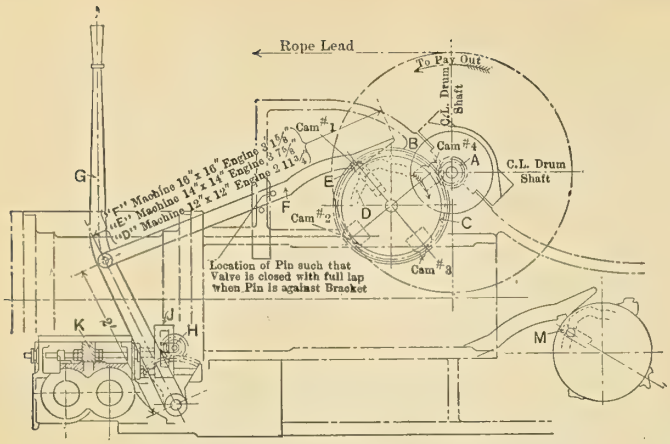


Fig. 7.—Side Elevation of Towing Machine

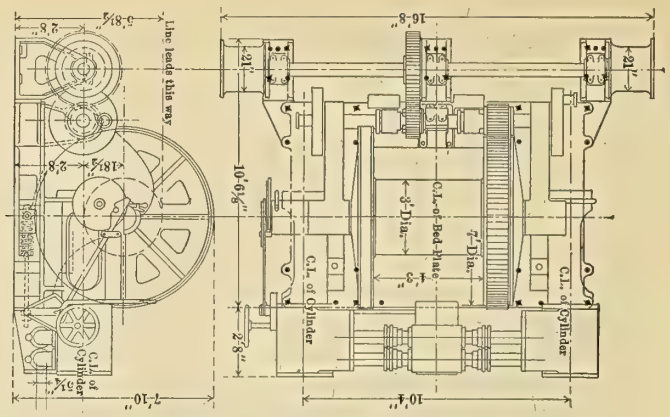


Fig. 8.—Plan of Towing Machine

or close the valve to its full movement. Cam 2 will operate in the slot in the reach rod to open the valve to its full extent, while cam 3 will close the valve down to a correct opening for safe speed when hauling in.

Change of Load

If, when towing, the load falls off, the engine will start to wind in and turn the gear plate *C* in the left-hand direction, and, closing the valve, will admit less steam to the engine until the load balances the engine power. If the load increases and the engine is overpowered, the gear plate *C* will turn in the right-hand direction and will open the valve to its fullest extent. If the line continues to pay out, the cam 1 will leave the slot in the reach rod *F* and be drawn to its inner position by the cam slot *D*, so that as it passes the slot in the reach rod *F* on the next revolution of the gear plate *C*, the cam 1 will not engage the slot in the reach rod *F*.

When the load falls off, so that the engine overpowers it and begins to wind the line in again, the cam 3 will almost immediately engage the slot in the reach rod *F* and close the valve down to the predetermined extent, at which it gives ample admission of steam to run the engine ahead at suitable speed, but not sufficient steam to let it run away under any circumstances.

The engine will then continue to wind in until it has made the same number of revolutions that it did in paying out, when the cam 1 will once more be thrust out by the cam slot *D* and engage with the slot in the reach rod *F* and bring the engine to rest at the same position that it was when overpowered by the load. If, however, it should happen that when the engine is winding in the line the load is again augmented and the engine overpowered, the cam 2 will engage the slot in the reach rod and at once reopen the valve to its fullest extent.

The valve *F* has 3/8 inch lap on each end. A motion of 5/8 inch from the center position to the right gives a port opening 1/4 inch wide, which is correct for forward running, and the safety cam 3 is set to close the valve to this point.

When the admission port is thus at safety opening for free forward running, the exhaust port is wide open. A further motion of 3/8 inch to the right of the valve *F* gives a total steam opening 5/8 inch wide, which is not, however, for forward running of the engine, but to admit quickly the steam required to meet and oppose the retreating pistons when the engine is being overhauled by the load and the piston reverses its direction at the ends of the stroke. The cams 1 and 2 are set to move the valve to the right to this extreme position when engaged with the slot in the reach rod *F*.

It will be understood from the above that the valve is operated through intermittent gearing opening the port fully when the engine is overhauled before the drum shaft has made a single revolution, thus giving immediate increase in steam pressure up to full pressure in the admission pipe.

After the valve is opened, it cannot be closed until the same length of line that has been paid out has been recovered. The engine may be overhauled to pay out an indefinite length of line, but will bring it all back. The valve is closed by intermittent gearing, in stages, bringing the line back to the same length to which it was originally set.

All steam passages are of large size, enabling the steam to flow freely from end to end of the cylinders and to bank up quickly in front of the overhauled pistons after each reversal at the end of each stroke.

The valve opening, while the engine is being overhauled, is much larger than is necessary to drive ahead at proper speed, in order that full power may oppose the paying out at all times, but after the engine starts to wind

Fig. 9.—Original Method of Guiding Hawser over Towing Arch

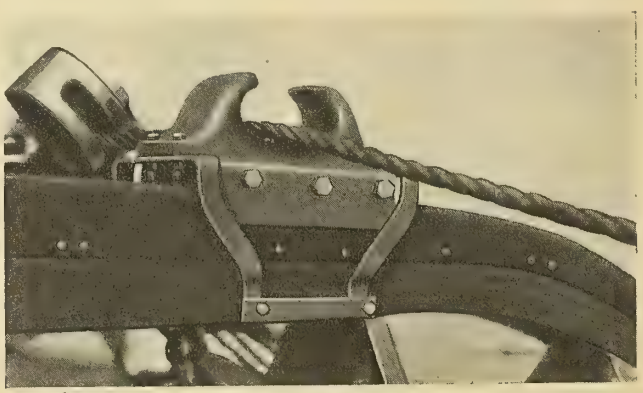


Fig. 10.—Sliding Guide Developed for Hawser over Towing Arch

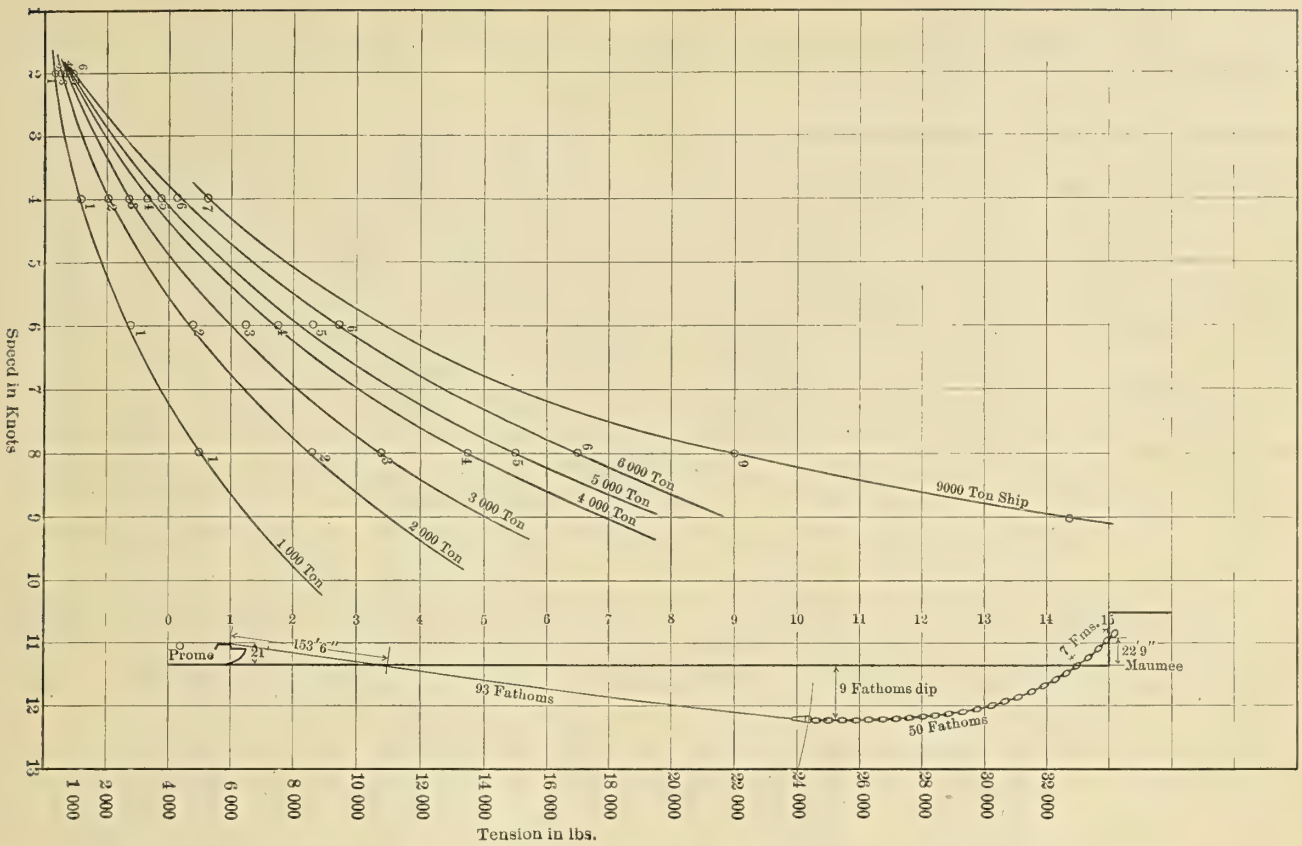


Fig. 11.—Chart of Towing Tension Curves and Method of Attaching Hawser to *Maumee's* Anchor Cable

in, the valve is partly closed to a point where the opening is sufficient to drive the engine at proper speed, but under safe control.

Arrangement of Hawser and Guide

It is obvious that for heavy towing work of the nature described precautions of all kinds must be taken to obviate the possibility of trouble in the control of the hawser and the vessel being towed, and it is essential that adequate means be provided for guiding the hawser properly in all conditions of wind and weather. At the beginning of the voyage the hawser was guided over the towing arch, as in Fig. 9, by a pair of very heavy tackle blocks, which were themselves secured by blocks and tackle at each side, as clearly seen in the illustration. Later on it was found desirable to modify this arrangement somewhat to give the hawser greater lateral freedom in relation to the arch, and a sliding guide was then developed and applied as in Fig. 10. This guide was kept in place on the towing arch by suitable side plates and by straps underneath, and was free to travel along the arch within the desired limits to accommodate itself to any slewing movement of the hawser due to swing and plunge of the vessel that was being towed.

Weighing the Tension on the Hawser

In order to make the towing proposition as flexible as possible and to provide an extra safeguard against undue stress on the hawser, Captain Karns adopted an interesting method of making the hawser connection back to the *Maumee* and of weighing the load on the hawser so that the speed of the *Prometheus* could be regulated to the requisite degree of safety. In the first place, instead of leading the hawser directly back to the *Maumee,* the anchor chain of the latter vessel was run out to a length of about 50 fathoms and the towing hawser was shackled to the end of this chain. The *Maumee's* anchor cable is made up of 2¾-inch stud links 18 inches long, the chain cable weighing 400 pounds per fathom. The great weight of the chain cable of, say, 50 fathoms, and the length of hawser connected to it, formed a deep catenary curve sagging 50 feet or more under the surface of the water, and the chain cable thus formed a spring or elastic connection capable of easing to a marked degree any sudden strains applied through the plunging or slewing of the vessels.

This arrangement is shown diagrammatically in Fig. 11, this chart showing also a number of curves which bring out the increase in tension on the tow line as the speed is increased. The chart covers ships of various tonnage and the curves are well worthy of study upon the part of engineers interested in nautical subjects.

The tension on the hawser was weighed at stated intervals each day and the speed of the *Prometheus* regulated accordingly. The method of finding this hawser load was as follows: A heavy platform scale was placed on the deck under the hawser at a point midway between the towing engine drum and the towing arch, and on this scale platform was placed an inverted jack with a strut reaching up into contact with the under side of the hawser. The jack was then operated to raise the hawser until a predetermined load was applied to the scales and the deflection of the hawser thus obtained was accurately measured by a gage consisting of a tall standard on which a horizontal arm was free to slide vertically, the amount of movement from normal position being read upon a scale attached to the upright standard. The readings were taken in sixteenths of an inch and a table was computed from which the actual tension on the cable at

any time could be found in pounds directly opposite the deflection as measured in sixteenths of an inch.

USE OF THE TABLE

The distance between the center of the drum on the towing machine and the hawser bearing on the towing arch was 49 feet 7 inches. The scale was placed exactly halfway between the two points and was so adjusted that the scale beam came to balance when a net load of 420½ pounds was applied by the pressure due to lifting the center of the hawser from a straight line—that is, the tare due to weight of jack and strut was compensated for so that it could be disregarded, and only the load due to the downward thrust brought about by pressure against the hawser taken into consideration in computing the tension.

The formula by which the table was calculated is as follows:

$$\frac{W \times 49 \text{ feet } 7 \text{ inches}}{4 \times \text{deflection in feet}} = \text{tension in pounds.}$$

Here W represents the net weight on the scale and the length 49 feet 7 inches is the hawser measurement from towing drum to arch. The tension is in pounds and the deflection is in feet. In the table the quantities in the first column represent deflection in sixteenths of an inch. The second column giving the tension on the hawser in pounds:

Deflection in Sixteenths of an Inch	Tension on Hawser in Pounds
10	100,000
11	91,000
12	83,500
13	77,000
14	71,500
15	66,500
16	62,500
17	59,000
18	55,500
19	52,500
20	50,000
21	47,500
22	45,500
23	43,500
24	41,500
25	40,000
26	38,500
27	37,000
28	36,500
29	34,500
30	33,500
31	32,500
32	31,500
33	30,500
34	29,500
35	28,500
36	28,000
37	27,000
38	26,500
39	25,500
40	25,000

Based upon the weighed loads on the hawser, as referred to above, the speed of the *Prometheus* was regulated so that the tension was usually well below 50,000 pounds, although the ultimate strength of the hawser was 300,000 pounds. This means that under certain conditions of sea and weather the speed was dropped to as low as four knots, while at other times it was increased to eleven knots. The average rate for the voyage was nine knots.

The longest leg of the trip, from San Francisco to Balboa, a distance of over 3,000 miles, was covered without stop the *Prometheus* steaming steadily at over nine knots and making the run in just fifteen days.

The entire undertaking was accomplished with complete success from start to finish and reflects great credit upon Captain Karns, his officers and men.

MARINE SOCIETY HOLDS ANNUAL MEETING.—The one hundred and forty-seventh annual meeting of the Marine Society of City of New York was held on January 8. With one exception the former officers of the organization were unanimously re-elected for another year.

Protection and Lubrication of Propeller Tail Shafts

BY A. MC NAB, M. E.*

The propeller tail shaft on a ship is without doubt the cause of many anxious moments to the chief engineer at sea and to the superintendent engineer ashore. The tail shaft should receive the greatest consideration, owing to its inaccessibility for repairs at sea, and because of the fact that through it all effective power of the engine has to be conveyed to the propeller. If its construction is such that at this point undue friction takes place, it means a loss of valuable power.

For many years the tail shaft was lubricated with sea water, which was allowed to enter through grooves in the lignum vitæ bush. When the tail shaft had two liners this resulted in serious galvanic corrosion, which commenced at the ends of the liners and would gradually eat its way into the shaft until there was a positive nick to the extent of over half an inch deep, and records in many cases prove that the strength of the shaft was so impaired that the shaft became insufficient for its work; many a good and valuable ship has been lost through the result of this fracture.

The protection of the tail shaft has given food for thought to many engineers, and various means have been adopted to try and overcome this corrosive effect. Of late years, continuous liners have been used, extending from outside the stern stuffing box into the propeller hub. These long liners, though extremely costly, were a cure for the corrosion of the shaft, providing they remained perfectly tight and the joint at the propeller hub remained tight also, but if there was a flaw in the manufacture or any injury in fitting, loosening up due to vibration or strain of work through which water could enter underneath the liner, the result was in most cases worse than before, as the corrosion of the shaft was taking place unseen.

In order to avoid this galvanic corrosion, of late years the stern tube has in many cases been filled with oil. Where a suitable fitting can be obtained which will hold the oil in the stern tube, this means has substantially proved an effective cure, always provided that the oil used is non-corrosive and otherwise suitable for the purpose. Given a good fitting and a suitable oil there is no question but that the trouble from galvanic corrosion is a thing of the past for all time.

Another serious trouble connected with the usual open ended stern tube is the entry of sand and grit into the stern bush. This sand accompanied with water makes an excellent mixture for grinding purposes, the result being that within a short time the shaft and bush become too slack for their work, with an attendant strain throughout the entire line of shafting and the usual "thump" heard in the engine room when the engines are reversed from "ahead" to "astern." A worn stern bush also produces excessive vibration throughout the ship.

Certain rivers are famous throughout the world for their injury to tail shafts and stern bushings, due to their sandy condition. Among the most notable are the Yangtze, in China; the Ganges, in India, and the Humber and Mersey, in England. Any arrangement which will keep the sand out of the stern tube of ships which frequent them is an immense boom to owners and engineers of steamers which are employed in these rivers.

Another serious trouble is the corrosive nature of the water on some coasts, caused by the decomposition of vegetable and other organic matter brought down by the

* President, the McNab Company, Bridgeport, Conn., sole representatives in the United States for Vickers' patent tail shaft appliances.

inland rivers. We need not look far in our country to find sandy and corrosive waters which put the owners to serious trouble and expense in consequence of this.

Therefore, it stands to reason that if the stern tube can be kept full of oil, neither the water nor the sand can enter and cause corrosion and wear by their presence.

We do not have to appeal to the engineer when stating that water *is not* a lubricant. The ordinary layman's common sense is all the appeal needed. No engineer would think of lubricating his engines with sea water if he could get oil. But, even in this advanced age of engineering, we find many cargo and first-class passenger ships "lubricating" the most important bearing, the one which has to convey the whole effective power of the ship's machinery, with sea water!

Many notable foreign governments and progressive steamship owners have adopted some system of oil lubrication for their tail shafts, and the advantage of this system is such that there can be no doubt it will in due time become almost universal practice. Some years ago a prominent consulting engineer of one of the largest European steamship companies, who was using oil lubrication for the tail shafts of the many vessels under his supervision, expressed the opinion that within the next ten years lubrication for the tail shafts by oil instead of water would become a standard and universal fitting.

A unique example of the advantage of such oil lubrication is the ferry steamer *Storeton,* which runs between Liverpool and Rock Ferry. This boat is continually running in sandy water and her work is most severe, as her engines are reversed thirty-four times every 15 minutes, and she runs incessantly 7½ hours a day, the average mileage in three months being 10,000 knots. She was built by the Ailsa Shipbuilding Company, Scotland, who fitted her with Vickers' patent oil-retaining appliance. She commenced work about March, 1910, and her shafts were first drawn in 1913. They have recently been drawn for the second time, when it was found that after more than six years' continuous service in the sandy waters of the Mersey the wear of the bushes and shafts together has been practically nil and the liners on the shafts appear as though they had been burnished, while the quantity of lubricant consumed was very small—almost negligible.

It is only reasonable to suppose that with oil, being a much better lubricant than water, the friction in the stern tube bearings must be materially reduced where oil can be used, and when it is considered that the friction surface of the stern gland and stern bush forms an important part of the total friction surface of a marine engine, it follows that with oil lubrication a larger proportion of the effective power of the engine must be conveyed to the propeller. In turbine steamers which have been fitted with oil lubrication it is found that the vibration is very materially reduced, a matter of great importance in passenger boats and especially in hospital ships carrying wounded men.

Oil lubrication has similar advantages on twin screw brackets as on stern tubes. With oil lubrication of the tail shaft any kind of a bush may be used. Lignum vitæ, which is the old-time favorite of many superintending engineers, lasts longer when oil is used, but gun-metal, brass or white metal bushes are suitable, while cast iron bushes have been frequently used with excellent results. In addition to their cheapness, cast iron bushes have the advantage of being, in many cases, less liable to develop galvanic corrosion outside the after-end of the stern tube.

Why is an Air Port?

"Old Mac", the Veteran Ship Draftsman, Explains the Practical Details of Air Ports and Their Installation

ABOUT a week after the "Why is a Door?" conversation, Old Mac had again come into the office after lunch and was sitting looking out of the window at a couple of submarines that were playing around a mile or so off shore. His gaze went past their low, heavy gray lines to the black high streak of a tramp that was pretty nearly hull down.

Mac and the fat chief engineer of this boat had indulged in frequent friendly and almost affectionate conversations while she was being overhauled in the yard, and as he looked he remembered the chief, the conversations, and the locker in the chief's room. As he remembered, his face relaxed and he smiled in a satisfied way.

Young Stevens and "Tek" had their heads together and were talking in an undertone. When Mac smiled "Tek" gave Stevens a nudge. Young Stevens went over and brought Mac out of his day dream with:

"Mr. Mac, why is an air port?"

Old Mac looked up in a startled sort of a way and I believe if it had been anybody else but Stevens some very hard, fast talk would surely have been started.

"Tek" moved over next to Stevens. Mac looked them over slowly.

"Why is an air port? Huh!" he exclaimed. "Well, an air port was invented to let air in and out. Incidentally it lets in light and you can look through it. It is a ship window made of brass or composition. They are usually round because it is easiest to finish them in this shape. On passenger boats rectangular air ports are used in some of the more elaborate quarters. On these boats rectangular air ports are located under the berth in the side of the upper deck house so as to light and ventilate staterooms below through a short, bright trunk. The gear for operating the port is worked from below. The only square air ports I ever heard of were those that an Irish friend of your father's used to josh the riggers about. He always claimed that the Swedish ships have square air ports so that the sailors can stick their square heads through them.

"An 8-inch air port is a small one and 18 inches is a large one; 12 inches and 15 inches are common sizes. A man can squeeze through an 18-inch port and not through anything much less. It lets in more light and is a fine ventilator, but it costs more money and means a wider spacing of stiffeners or frames to clear. You fellows know, of course, that an air port hinges inward and is therefore on the inside. Near the waterline and where there are hard weather conditions air ports are smaller because they are stronger. Here also fixed lights are used. Deadlights and specially strong covers are some-

times fitted where there is danger of the air port's failure.

"A 12-inch air port weighs complete with a cover about 100 pounds and costs installed about $25 (5/4/2).

"Air ports are pretty well standardized. Most firms have standard drawings and patterns for various sizes. Some builders buy them on the outside. Not long ago we got a lot of them from the Delaware Marine Supply Manufacturing Company. They had them on hand and we were rushed. The details of an air port need not bother you. Just see that you get clearance—that is all that is necessary. On outside plans remember to be guided by figures alone and be careful how you use some of those. What we have to worry about is their location and what you have seen a lot of times—an air port schedule.

"An air port has to be located in the shell or house plating, so that its frame does not foul plate laps, stiffeners, frame flanges, etc. It must be possible to open the light and hinged cover without fouling stiffeners or stiffener and beam brackets. The bolting is universal in the air port frame—that is, the number of holes is such and they are so arranged in reference to the vertical and horizontal axes that the cover, light and frame can be changed from up to down or sideways. Generally both cover and light hinge up and are held by a latch hook or by a hook and chain fastened by a small eyebolt. However, the cover may hinge up and the light to the left or right.

"Five feet three inches is the height of the average person's eyes, so that the center of the light in an air port should be about 5 feet 3 inches above the floor or deck. Remember that when a wood deck is fitted you must allow 2½ inches to 3 inches and locate the air ports on the steel plans just that much higher. Some fellows can only see steel when they work on steel plans. Of course air ports must be located to conform to the general appearance scheme of the outside of the deck house as regards panels, pilasters, doors, etc. The arrangement of furniture in the rooms has to be considered also.

"It used to be that the yard wanted the early location of air ports, etc., so that the hole in the plate could be cut to advantage. It is all right to give them this early location unless some change in the quarters or furniture details does not have to be made later. You can't move a cut hole, and nearly always somebody wants to rearrange quarters at the last moment, so it is wise to remember to forget to show the detailed location of air ports. Now, however, a fellow in the yard has no trouble in burning out an air port hole after the plating is in place and riveted up. Often an air port is the only way to ventilate some compartment or the only good way for electric and compressed air leads. Then an air port or two may be cut out early in the game to please the yard, but remember this early location is dangerous business.

"Sometimes an air port may leak a little and at times they all sweat so that a cupped drip is provided either as a part of the frame of the air port or built into the ceiling around the air port. A small drain is fitted to carry off this drip. Where the flare of the ship is excessive special attention must be paid to locating the drain at the lowest point.

"In way of anchors, etc., where the glass in the light might be broken the frame of the air port does not protrude through the shell plate, and the plate is not cut except with a few 2-inch diameter holes in the way of the light.

"An air port schedule is a tabulated list of the air ports on the ship. It shows the number wanted of each kind, size, etc. It gives also the length of the spigot or lip part of the frame that protrudes about an eighth of an inch beyond the outside of the plate. The thickness of the plate, of course, determines the length of the spigot. The air port flange and the spigot edge are generally flat, and where the shell plate is curved a tapered liner is supplied to fill up this curvature, the spigot being made correspondingly longer. When weight saving is important the frame flange is cored out and a narrow chipping strip is provided that can be cut to suit the curved plate. This is done on torpedo boat destroyers. Here the frame flange is also scalloped out between the holes to save weight.

"This schedule or list shows what kind of glass is wanted in the lights—clear, frosted, or wire inserted. When an air port opens into a private room, bath, etc., from a deck or public part of the ship, ground or frosted glass is used in the light or some sort of blind is fitted on the inside.

"The schedule shows, also, where a grating or screen is to be furnished. Fine bronze wire insect screens are often fitted to keep out mosquitos and flies. Heavier screens or grating are fitted to protect the light and partly close the opening in steerage quarters, storerooms, cells, etc., where trouble would result from too ready access or passage.

"Again this list must state whether or not the air port is to have a cover. It should also state how the port hinges and specify how the drain is to be furnished.

"Most weather air ports have a watershed and the list should take care of this also. This watershed is a brass or composition rim or lip that is fastened on the outside of the plate and extends over the upper half of the port so as to shed water clear of the port proper. It has about the same diameter as the spigot and fits down on it, being fastened to the plate with screws or tap rivets.

"For the purpose of ventilation when there is no regular system, a sheet metal scoop piece is fitted to the open air port in such a way that it extends out against the direction of the wind and forces air in through the port. It has a latch and can be set to suit.

"This schedule takes account of fixed lights, deck lights, prisms, etc. In the case of a wood deck this flange of the light frame is let into the wood and heavy glass (preferably wire inserted) is used. For steel decks this flange is on top of the deck and has a chamfered edge.

"Remember that in the pilot house the fittings around the compass are sometimes made of non-magnetic material. On the smaller boats fixed material within a radius of about eight feet should be non-magnetic. When conditions warrant it this radius should be increased to about twelve feet. Movable material within a radius of fifteen feet should be non-magnetic."

The whistle blew. Stevens and Tek hurried over to their boards. Mac took another long look at the submarines, put on his glasses and with a resigned expression started to alter a drawing that he had made about a week before and that some of the "higher ups" (as he calls them) had (to use their expression) changed slightly. The changes, though slight, were radical. The old man's pride had been hurt and he made no effort to hurry. He watched the submarines at intervals all afternoon.

ANNUAL MEETING OF ENGINE AND BOAT MANUFACTURERS.—The annual meeting of the National Association of Engine and Boat Manufacturers will be held at the United Engineering Societies Building, 29 West Thirty-ninth street, New York city, at noon on February 1.

SHIPBUILDERS ACTIVE IN NOVA SCOTIA.—Six shipyards in the vicinity of Parrsboro, Nova Scotia, are engaged in the construction of schooners. These vessels range from 200 to 600 tons each.

Pushing and Speed Tests of River Towboats

Speed and Thrust of Tunnel Stern Towboat with Propellers of Varying Pitch and Area—Comparison with Sternwheel Boat

BY M. VON PAGENHARDT*

By permission of Major Smith, of the Mississippi River Commission, the writer, representing the Kansas City Missouri River Navigation Company, was given the opportunity of conducting a series of tests on the twin-screw tunnel towboat *Inspector* and sternwheel towboats *Wynoka* and *Saturn* for the determining of—(1) The thrust per indicated horsepower of the tunnel towboat *Inspector* with propellers with different pitch and area, while pushing against a barge tied to the shore, in a current speed of about four miles per hour; (2) The speed per indicated horsepower of the tunnel towboat *Inspector* with propellers of different pitch and diameter while running light. (3) The maximum thrust per indicated horsepower of the tunnel towboat *Inspector* and of the sternwheel towboats *Wynoka* and *Saturn* while pushing against a barge tied to the shore, in a current speed of about four miles per hour.

The purpose of this investigation was twofold: namely, the determination of the respective pushing power of the two different types of towboats under exactly similar conditions, and also the determination of the tendency of the curves thus obtained for the calculation of the maximum power obtainable in the tunnel boat screw of approximately five feet six inches diameter, or a sternwheel of approximately twenty-four feet diameter.

The tests were made October 7-17, 1915, under the supervision of Mr. Hilliard, superintendent of the United States dredge fleet of the Mississippi River Commission, by the writer, who was assisted by the junior engineer, Mr. E. S. Bonnell, and by Mr. D. J. Mackie, superintendent of the fleet of the Kansas City Missouri Navigation Company.

General Arrangements of the Test

In order to determine the thrust of a Western river towboat, which pushes its tow of barges instead of pulling it on a towline, arrangements had to be made to measure accurately this thrust of the towboat pushing against a tow securely anchored in reasonably deep water in a current equivalent to the upstream speed of a heavy tow. The current speed at this particular time was in the neighborhood of four miles per hour, or twice as much as during the low-water season, and therefore the speed of four miles per hour was equivalent to the upstream speed of a heavy tow.

The Government dredge fleet lying three barges abreast at the Arkansas shore afforded an excellent place for this pushing test. The depth of water outside of the fleet exceeded 40 feet, and a barge tied to the outside of this fleet was in comparatively unlimited water. Two dynamometers 17 feet center to center were fastened onto the stern end of a barge 80 feet in length and 24 feet in width, drawing only 12 inches, whereas the towboats were drawing at least 3 feet. Care was taken not to have any boat or barge alongside the towboat, so as not to interfere with the proper flow of the water to and from the propellers.

The dynamometers were in form of cast iron plungers with an area of 100 square inches each, allowing a reading of 100 to 1, and the gages were tested before and after the completion of the tests and corrections noted.

For the determination of the generated power in the engines, indicators were installed, one on each cylinder, and the testing force was distributed in such a way as to read simultaneously the thrust on the dynamometers, the boiler pressure, the number of revolutions per minute and to take a double set of indicator-diagrams on each cylinder—during each period of constant revolutions.

For the speed test no special arrangements were made, as there is laid out and properly maintained a measured mile opposite the dredge plant, following an easy bend of the river in mid-channel.

The main particulars of the vessels to be tested were as follows:

Twin Screw Tunnel Towboat "Inspector"	
Length between perpendiculars	144 feet
Beam, molded	26 feet
Depth, molded	6 feet
Coefficient of waterlines equal	.1821
Coefficient of typical cross section	.989
Block coefficient	.705
Draft to C. W. L.	3 feet 6 inches
Draft under test conditions	3 feet 9 inches
Displacement under test conditions	300 tons
First set of screws (built-up propeller):	
Diameter, 5 feet 6 inches.	
Pitch, 8 feet.	
Developed area each, 12.5 square feet.	
Second set of screws (built-up propeller):	
Diameter, 5 feet 6 inches.	
Pitch, 7 feet 9 inches.	
Developed area each, 15 square feet.	
Third set of screws (solid propeller):	
Diameter, 5 feet 6 inches.	
Developed area each, 16.6 square feet.	
Pitch of starboard wheel, 6 feet.	
Pitch of port wheel, 5 feet 6 inches.	
Number of engines	2
Diameter, high-pressure cylinder	10 inches
Diameter, intermediate-pressure cylinder	15¼ inches
Diameter, low-pressure cylinder	25⅝ inches
Stroke	18 inches
Revolutions per minute	190
Indicated horsepower	750
Sternwheel Towboat "Wynoka"	
Length between perpendiculars	171 feet 6 inches
Beam, molded	36 feet
Depth, molded	5 feet 6 inches
Draft to C. W. L.	4 feet
Draft under test conditions	3 feet 6 inches
Displacement under test conditions	540 tons
Two high-pressure engines.	
Bore of starboard engine	22¼ inches
Bore of port engine	22 inches
Common stroke	96 inches
Indicated horsepower at 22 revolutions per minute	800
Diameter of wheel	24 feet
Length of bucket	23 feet
Width of bucket	30 inches
Number of buckets	16
Sternwheel Towboat "Saturn"	
Length between perpendiculars	99 feet
Length overall	118 feet
Beam, molded	20 feet
Draft under test conditions	3 feet
Displacement under test conditions	145 tons
Two high-pressure engines.	
Bore of engines	9½ inches
Common stroke	60 inches
Indicated horsepower turning 24 revolutions per minute	137
Diameter of wheel	15 feet
Length of bucket	13 feet
Width of bucket	20 inches
Number of buckets	13

Method of Conducting Tests

Readings were taken every fifteen seconds simultaneously at both dynamometers, revolution counter, steam gage, vacuum gage, and two sets of cards were taken on each engine, while the revolutions per minute were kept constant for a period varying between five and twelve minutes.

At least four points were determined of the curve for each propeller. The current of the river was measured

* Naval Architect, Kansas City, Mo.

whenever the weather permitted, and the resistance of the pushing boat in the current was determined by hanging the boat on one dynamometer, which resistance was introduced as the constant for all readings of that boat.

The tests were made in four groups, as follows:

1. Pushing test of *Inspector* with first set of propellers.
2. Speed test of *Inspector* with barge in tow, first set of propellers.
3. Speed test of *Inspector* running light, with first set of propellers.
4. Repeating speed test running light, with first set of propellers, after removing forward backing rudders, which were found badly bent, and after straighening after rudders.
5. Repeating pushing test of *Inspector* with first set of propellers.
6. Pushing test of *Inspector* with second set of propellers.
7. Speed test of *Inspector* with second set of propellers.
8. Pushing test of *Inspector* with third set of propellers.
9. Pushing test of *Inspector* with starboard propeller only of third set of propellers.
10. Speed test of *Inspector* with port propeller only of third set of propellers.
11. Speed test of *Inspector* with third set of propellers.
12. Pushing test of sternwheel towboat *Wynoka*.
13. Pushing test of sternwheel towboat *Saturn*.
14. Speed test of sternwheel towboat *Saturn*.

Results

The maximum pushing power of the twin-screw towboat *Inspector* was 18,841 pounds with 979.1 indicated horsepower, or 19.25 pounds per indicated horsepower. The maximum pushing power or thrust of the sternwheel towboat *Wynoka* was 17,700 pounds with 587.1 indicated horsepower or 30.2 pounds per indicated horsepower, or the thrust per indicated horsepower of the sternwheel towboat was 57 percent higher than the thrust per indicated horsepower of the tunnel towboat *Inspector*. If, however, we compare their displacements we find that the pushing power of the tunnel towboat was 62.8 pounds per ton of displacement against 32.8 pounds per ton of displacement of the sternwheel boat *Wynoka*, or superior to the sternwheel towboat by 91 percent. The fact must be mentioned, however, that the *Wynoka* was only allowed 165 pounds steam pressure instead of 200 pounds, which she carried when a new boat. With the latter pressure she might have indicated 700 or 750 indicated horsepower under similar conditions, or as much as 40 pounds per ton of displacement, in which case the tunnel boat *Inspector* would still have an advantage of 57 percent in thrust per ton of displacement over the sternwheel boat *Wynoka*.

The additional displacement, however, of the *Wynoka* over the *Inspector*, 540 tons against 300 tons, showed an additional resistance in the four-mile current of only 21.4 percent, 825 against 680 pounds, leaving a net thrust of 18.6 pounds per indicated horsepower in the *Inspector*,

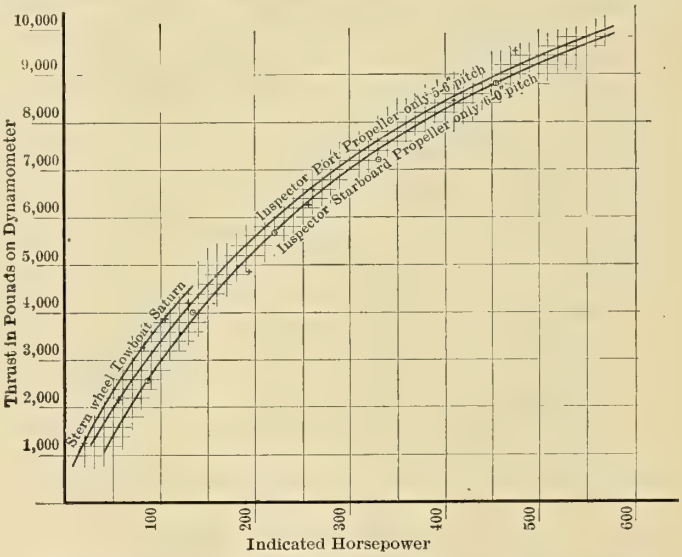


Fig. 2.—Pushing Test; Relation of Thrust and Indicated Horsepower. Twin-Screw Tunnel Towboat *Inspector* and Sternwheel Towboat *Saturn*.

against 28.8 pounds per indicated horsepower in the *Wynoka*, which is still an increase of 55 percent of net thrust per indicated horsepower at this current speed of four miles per hour. At the higher towing speeds this difference will still be less but as long as we have to do with towing speeds there will still remain a superior net thrust per indicated horsepower of 40 to 50 percent in the sternwheel towboat over the tunnel towboat of similar dimensions.

The thrust of the tunnel towboat might be increased considerably with a still further reduction of the pitch, a still further increase in revolutions per minute, and a still further increase of the developed area. So may the thrust of the sternwheel towboat be increased by reducing the diameter of the wheel, increasing the area and increasing the revolutions per minute. The attained comparative data will, therefore, still be indicative of the comparative thrust efficiencies.

We further find that the fuel consumption per hour of the 960 indicated horsepower tunnel towboat, figuring 2½ pounds per indicated horsepower, is 2,400 pounds, whereas the fuel consumption of the 630 indicated horsepower sternwheel boat having high-pressure engines, figuring five to six pounds of coal per indicated horsepower, is 3,150 pounds to almost 4,000 pounds per hour. Of course, this comparison of fuel consumption is no criterion for the sternwheel boat type in general, as the fuel economy in tandem compound engines could easily be reduced to three pounds per indicated horsepower, but the comparison is indicative of the importance of multi-stage expansion of steam and the general fuel saving and its effect in plant efficiency.

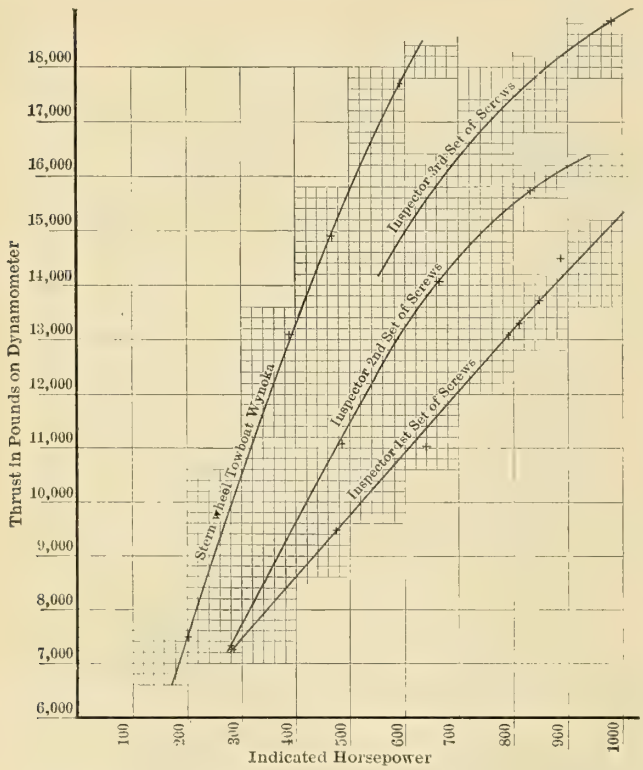


Fig. 1.—Pushing Test; Relation of Thrust and Indicated Horsepower; Twin-Screw Tunnel Towboat *Inspector* and Sternwheel Towboat *Wynoka*.

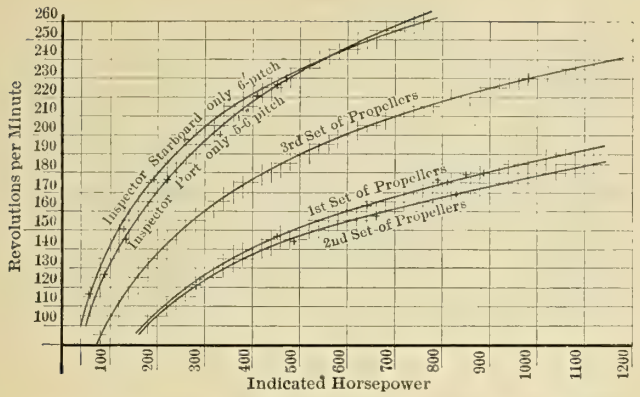


Fig. 3.—Pushing Test; Relation of Revolutions per Minute and Indicated Horsepower. Twin-Screw Tunnel Towboat *Inspector*.

The tests on the *Inspector* allow us to make the following deductions:

Deductions from Tests of Twin-Screw Tunnel Stern Towboat "Inspector"

The thrust per indicated horsepower increases with the increase of the developed blade area and with the decrease of the pitch.

An increase of the revolutions per minute results in a higher thrust per blade area up to about 260 to 300 revolutions per minute, at which point the thrust per blade area would begin to decrease.

A propeller turning 260 to 300 revolutions per minute is more efficient than a propeller designed to turn only 180 to 200 revolutions per minute.

A tip speed of 4,000 to 5,000 feet per minute is desirable.

A ratio of pitch to diameter of one, or even less than one, is desirable.

A ratio of developed area to disk area of 70 percent and more is desirable.

A propeller of solid construction is preferable to a propeller of the built-up construction, as the solid propeller offers less resistance to the water.

Whatever applies to a towing propeller applies also to a speed propeller, or a good towing propeller is also a good speed propeller, whereas a good speed propeller is not always a good towing propeller. A propeller of courser pitch and less area and less revolutions per minute will give almost as good results for speed as a towing propeller of high revolutions per minute; and the lesser revolutions per minute of the courser pitch propeller results in a saving in wear and tear of the machinery.

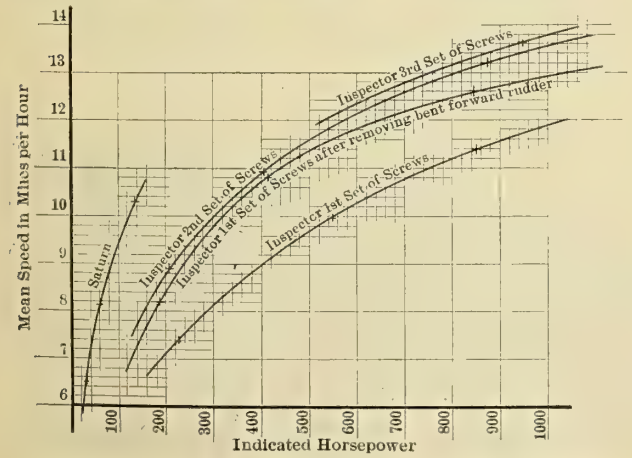


Fig. 4.—Speed Test. Twin-Screw Towboat *Inspector* and Sternwheel Towboat *Saturn*

The apparent slip reduces with a decrease of the pitch and an increase of the area in our case from almost 30 percent to almost 20 percent.

The thrust of the screw is constant at each revolution per minute, and not fluctuating as in a sternwheel boat.

A properly designed tunnel towboat drawing 4 feet can possibly be designed to generate 1,500 indicated horsepower with a possible thrust of 30,000 pounds.

The test of the sternwheel towboat *Wynoka* allows us to make the following deductions:

Deductions from Tests of Sternwheel Towboat "Wynoka"

The thrust per bucket area increased very rapidly with the increase of the circumferential speed.

A circumferential speed of 1,500 feet per minute and more is desirable.

Each square foot of bucket area can absorb 13 to 15 indicated horsepower and produce a thrust of 300 to 350 pounds.

The thrust fluctuating as much as 15 percent either way even with almost constant revolutions per minute.

A sternwheel towboat of 600 indicated horsepower is in pushing power equal to a tunnel towboat of 900 indicated horsepower.

A sternwheel towboat of 1,000 indicated horsepower might in pushing power be equal to a tunnel towboat of 1,500 indicated horsepower, both drawing not more than 4 feet.

The tests of the sternwheel towboat *Saturn* allow us to make the following deductions:

Deductions from Tests of Sternwheel Towboat "Saturn"

The thrust per indicated horsepower rapidly decreases with the increase of the indicated horsepower.

The thrust per indicated horsepower is greater in a small boat than in a large boat.

Conclusions

The tests give us a right for the following conclusions:

Five hundred and eighty-seven indicated horsepower produced in the sternwheel towboat *Wynoka* 190 effective horsepower, or 32.4 percent plant efficiency.

Nine hundred and seventy-nine indicated horsepower produced in the tunnel towboat *Inspector* 202 effective horsepower, or 20.7 percent plant efficiency.

Or the sternwheel power transmission was superior to the tunnel screw transmission by 57 percent.

On the other hand, the tunnel towboat type carries three indicated horsepower per ton of displacement against the sternwheel towboat's one and one-half, or twice as much.

And the tunnel towboat should have a superior fuel economy to the sternwheel towboat owing to the use of triple-expansion engines, or possibly fuel oil engines, which are particularly well adapted for the direct propeller drive.

As a general rule, one might say that a sternwheel towboat of 600 indicated horsepower is equal to a tunnel towboat of 900 indicated horsepower in pushing power, but inferior in speed and inferior in fuel economy. On the other hand, the sternwheel boat is cheaper in construction, due to the peculiar condition of the shipyards on Western rivers, which are not acquainted with the construction of tunnel towboats, but well acquainted with the construction of the sternwheel type of towboat.

Regarding the construction of larger tunnel towboats, the tests have demonstrated that 1,300 indicated horsepower could be absorbed efficiently in two 5 feet 6 inches diameter screws and that a 1,500 indicated horsepower tunnel towboat, and even a 2,000 indicated horsepower

tunnel towboat drawing 4 feet of water, are in the realm of possibilities.

The sternwheel towboat can always hold its own in competition with the tunnel towboat up to a certain horsepower, owing to cheaper hull construction, cheaper machinery and smaller investment in engine horsepower. The future sternwheel towboats should, however, strive after higher revolutions per minute with corresponding increase of circumferential speed, increase of bucket area and increased fuel economy.

With an increase in channel depth, however, the tunnel towboat type gains quickly in superiority over the sternwheel towboat type. Not only does the ratio of effective horsepower to indicated horsepower grow quickly, but the hull dimensions decrease rapidly in the tunnel towboat type as the draft increases, so that the writer believes that it would be unadvisable to build any more sternwheel towboats of larger power, such as the 2,000 horsepower *Sprague*. It is preferable to build tunnel towboats of considerably smaller dimensions and equally effective pushing power and considerably superior fuel economy and smaller operating cost.

The question of handling ability is purposely not touched upon. It should be considered separately and individually.

Port of Astoria Steamship Terminal

New System of Municipal Docks with Coaling Facilities, Grain Elevator and Freight Piers Developed at Astoria

BY J. P. NEWELL *

THE port of Astoria decided in the early part of 1914 to construct a system of municipal docks, with coaling facilities, grain elevator and other means of caring for ocean traffic as needed. A tract of about 60 acres, with a deep water frontage of 1,850 feet, was purchased, and the firm of which the writer is a member was employed to design and construct the works.

Since the greater part of the tract lay below mean low water, a system of piers and slips was the natural form of development. The effect of the tides is felt along the Columbia River over 100 miles inland. The immense volume of water thus set in motion, together with the natural flow of the river, produces strong currents which on the ebb sometimes reach four miles per hour.

The first problem confronting the engineers was the location of slips which could be safely and easily entered at any stage of the tide. Satisfactory results have been obtained by placing Slip No. 1 at an angle with the stream of about 50 degrees and making it 400 feet wide at the entrance and 250 feet at the rear end. The adjacent waterfront is not yet built upon, consequently the tides running in either direction now form an eddy in front of the slip, so that vessels enter or leave without the slightest difficulty. The eddy will probably disappear when the adjoining property is filled in to the bulkhead line, but it is believed that the shape and location of the slip will prevent trouble at any time. The dimensions of Slip No. 2 will depend somewhat on the plans of those owning the land on the west side of it, but these plans will be subject to the approval of the Port Commission and

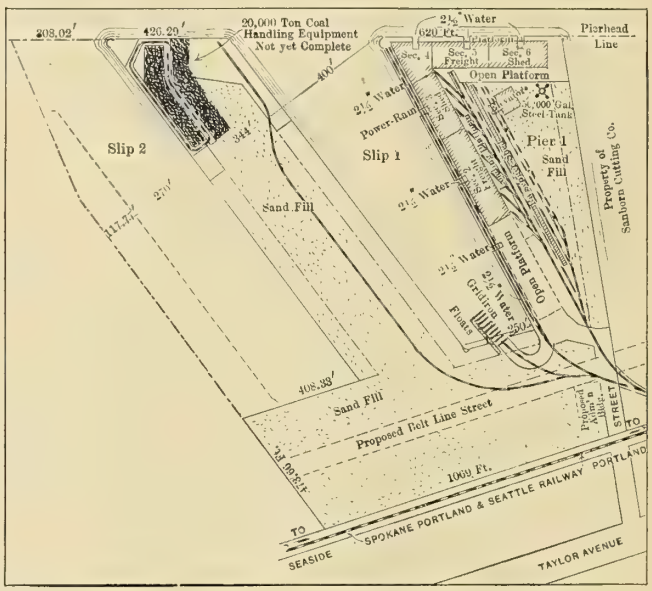


Fig. 2.—General Plan Astoria Piers

Fig. 1.—Pier No. 1 Nearing Completion

* President of Newell, Gossett & Walsh, civil engineers, Portland, Ore., and president of the Portland, Oregon, Association of Members of the American Society of Civil Engineers.

Fig. 3.—General View of Municipal Docks

they will be guided by the experience gained with the present construction.

General Type

The general type of construction is a pile and timber pier enclosing a sand fill kept in place by timber lagging against the piles, with riprap in exposed places. The building is of wood except the walls, which are of Denison interlocking hollow tile with reinforced concrete columns supporting the roof trusses. Steel roller doors and windows with steel sash set directly in the tile work are used

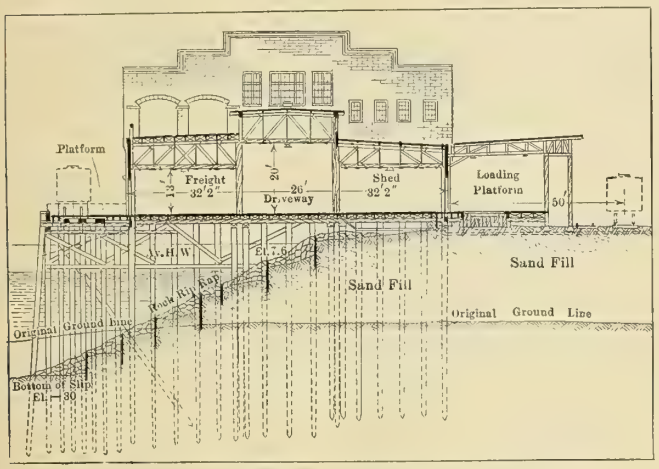


Fig. 4.—Cross-Section, West Side Pier No. 1

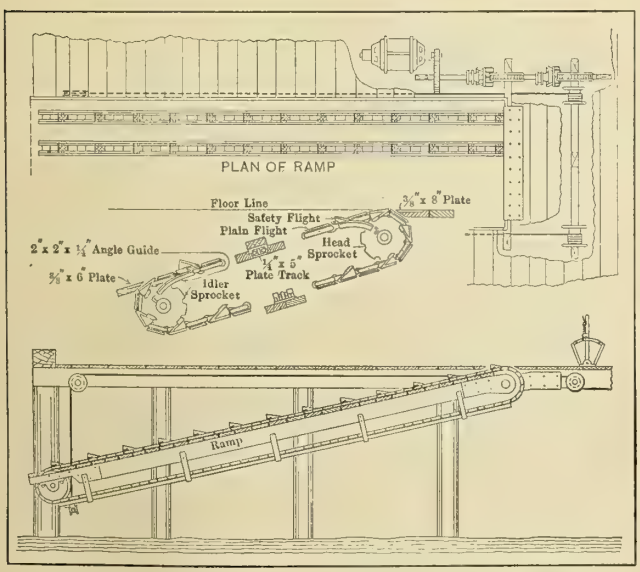


Fig. 5.—H and U Safety Booster for Astoria Piers

Fig. 6.—Interior of Pier Shed

throughout. Continuous monitor windows and the use of white paint on the interior give exceptionally good light. Interior posts supporting the roof have been used with considerable economy and have been found to cause no inconvenience.

Freight Handling

No crane equipment has yet been provided, reliance being placed for the present on ships' tackle, but the front platform is wide enough for a gantry crane with one leg on the roof and the other on the edge of the wharf. It is planned to use dock trucks, but they have not yet been installed.

Adjustable Ramps

Six slips have been provided with adjustable ramps for the handling of freight to and from river boats and barges. The ramp platforms have been equipped with a special booster chain to carry the loaded trucks up the incline. Two flat top chains are used, running on rollers in guides spaced to suit the hand trucks in use on the dock. Sprocket wheels mounted on the hinge shaft drive the chains, which have semi-attached steps which engage the truck wheels until the top of the incline is reached,

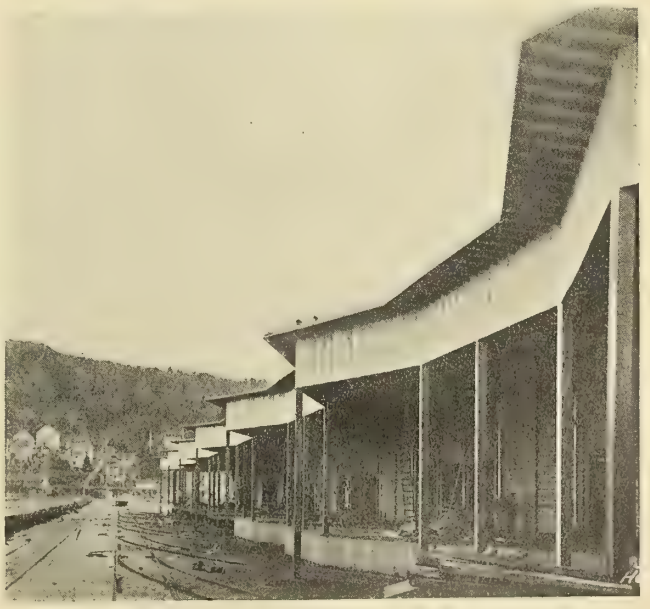


Fig. 7.—"Herring-bone" System of Tracks Leading to Pier Shed

UNION OIL COMPANY'S TANK STEAMER LA BREA

Built by Union Iron Works Company

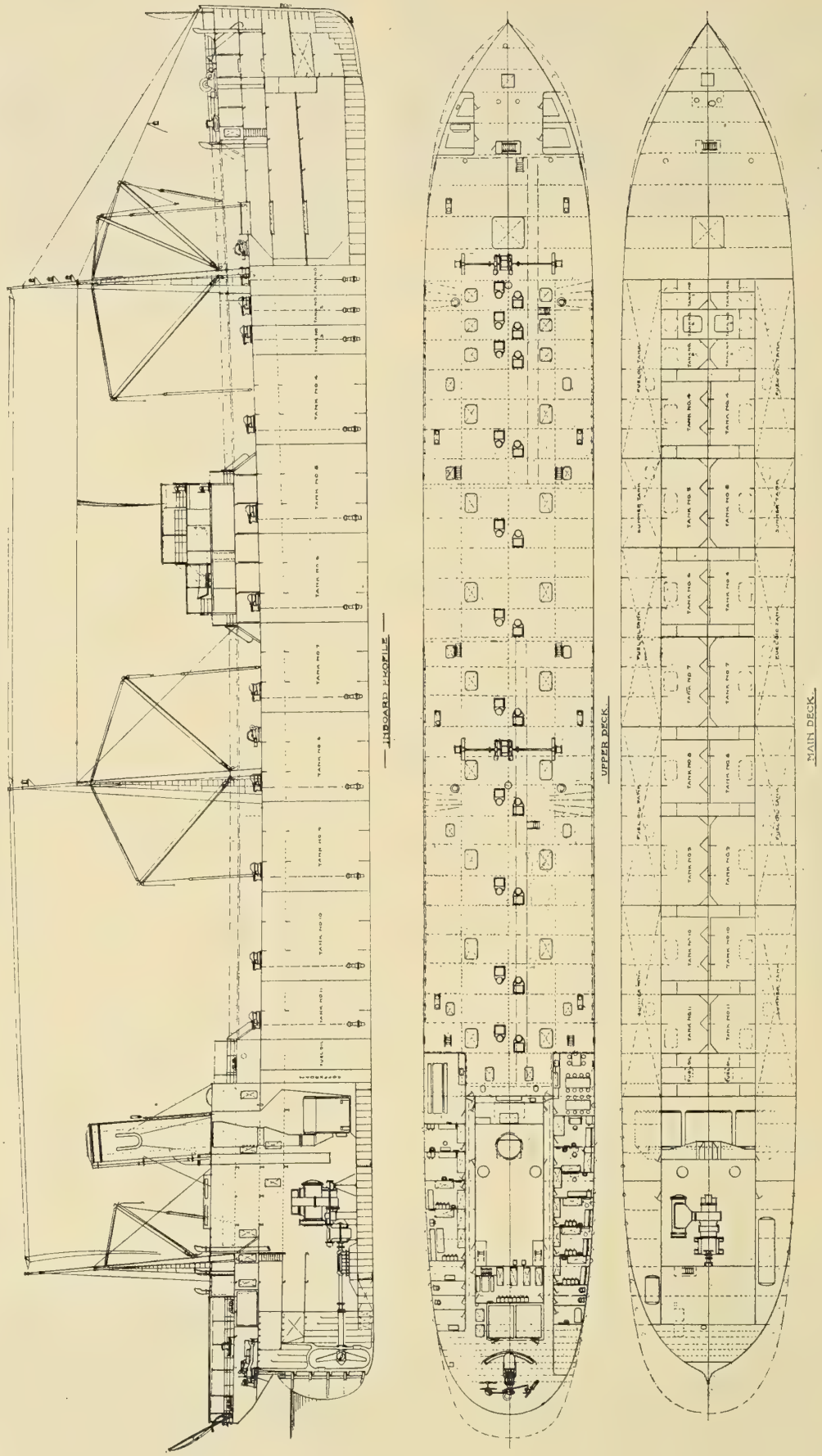


Fig. 1.—Inboard Profile and General Arrangement Plans of Upper and Main Decks

when they drop automatically and pass through the opening in the floor with a clearance of less than one-fourth inch.

The railroad tracks are carried across the slips by movable platforms that are raised and suspended above the openings when the slips are in use. All these operations are performed by means of a 7½ horsepower A. C. motor placed under the dock floor, and controlled by a drum-type controller with reversing handle connected with reversing variable speed motor. The three levers controlling the various operations are interlocking and engage friction clutches under the dock floor. The cost of a ramp complete, with steel trussed beams and all mechanical and power equipment, was $3,000 (£615).

Three rails have been laid along the front of the dock, so spaced that the center one can be used with either of the others. Cars can thus be set close to the edge for unloading freight into chutes or at a sufficient distance back to permit skips to be landed in front of the cars. This gives most of the advantages of double track with less space and a shorter distance for trucking the freight which goes through or into the warehouse.

The "Herring-bone" system of tracks in the rear is specially designed for quick handling of cars. It consists of a series of short parallel spurs, each holding two cars and running diagonally into the freight platform. The cars are entirely under the shed roof, which is important in a wet climate like that of Astoria. The platform is on a level with the car floors, and the end car on each spur can be reached from either side. Three cars can be reached from any one door of the warehouse, making it possible to close alternate doors and use the space in front of them for storage. Electric light plugs are provided along the wall so that connections can readily be made for lights in the cars. The cars on any spur can be moved without disturbing any other, which greatly facilitates switching, especially when handling L. C. L. freight.

The contractors were: J. A. McEachern Company, of Seattle, for the substructure; C. L. Houston, of Astoria, for the superstructure; Tacoma Dredging Company for the dredging and filling. Helser & Unden, of Portland, designed and constructed the booster. F. J. Walsh, of Newell, Gossett & Walsh, Portland Ore., was chief engineer; R. R. Bartlett, assistant engineer in charge of designing; and K. E. Hodgman, assistant engineer, in charge of field work.

Oil Tank Steamer La Brea*

Electric Pumping Equipment and Performance of Reduction Gear Turbines on New Tank Steamer for Union Oil Company

BY HUGO P. FREAR

The S. S. *La Brea* is the first tank steamer equipped with independent submerged cargo pumps in each compartment, port and starboard, operated by electric motors on deck, and also the first to be fitted with reduction gear turbines, so far as the writer knows. Otherwise the vessel differs little from many tankers built on the Isherwood longitudinal system of framing, and therefore these two items, especially the electric pumping system, will receive the most attention.

The *La Brea* is 435 feet in length, 56 feet in breadth and 33 feet 6 inches in depth, molded, and was the first vessel of this particular class built by the Union Iron Works Company, San Francisco. The contract was dated May 14, 1915, and delivery made February 29, 1916.

There have since been completed or contracted for by the same builders thirteen additional tankers off the same scrieve, all with pump rooms and ordinary pumping systems except one vessel for the Pan-American Petroleum Transportation Company, which will have the same pumping system as the *La Brea*, but with only one pump to each transverse cargo compartment in lieu of two, as fitted on the *La Brea*.

Ten of these additional tankers have reduction gear turbines and three triple expansion reciprocating engines of approximately the same indicated horsepower as the shaft horsepower of the turbines. In each case the length of

* Extract from paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1916.

Fig. 2.—S. S. *La Brea* in Ballast Trim

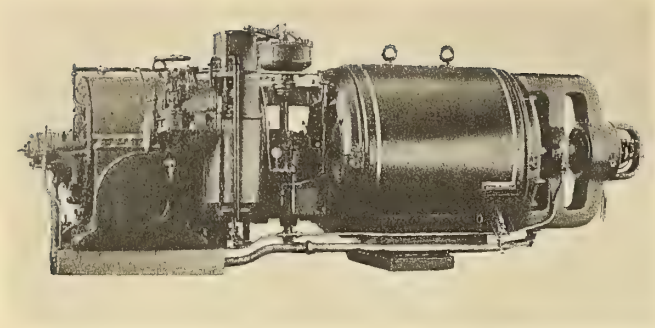


Fig. 3.—Turbo Generating Set

machinery space, forehold and overall length of the oil compartments, including pump room and cofferdams, are the same. The position of the pump room, cofferdams, length of fuel tank and length of some of the cargo tanks vary more or less to suit the owners' views.

Of this class, the tanker following the *La Brea* was the *Los Angeles,* also for the Union Oil Company, of California, but fitted with triple expansion reciprocating engines, pump room and ordinary pumping equipment of standard capacity and efficiency. These two vessels, delivered within a month of each other and owned and operated by the same company, offer a most excellent opportunity for a comparison of their performances on the voyages so far completed.

The propulsion equipment of *La Brea* was furnished by the General Electric Company and consists of a Curtis turbine of the type developed for ship propulsion work, operating at a speed of 3,500 revolutions per minute, direct connected to a double reduction gear suitable for reducing the speed of the turbine to 90 revolutions for driving the propeller. The normal rating of the turbine and gear is 2,600 brake horsepower, with a steam pressure of 200 pounds at the throttle valve, 50 degrees superheat and exhausting into a vacuum of 28½ inches, measured at the exhaust inlet with the barometer at 30 inches. The complete weight of the turbine and reduction gear, including all parts for the throttle valve and thrust shaft coupling, is about 110,000 pounds.

The electric cargo pumping system consists of twenty-two Ideal 4-inch rotary pumps built by the Union Tool Company, Torrance, Cal. They are designed especially

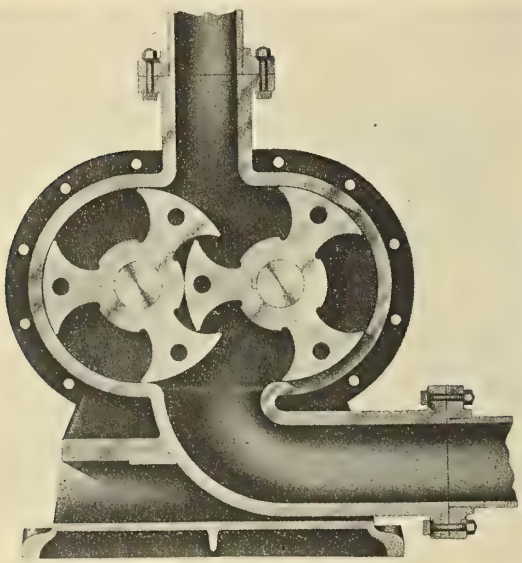


Fig. 4.—4-Inch Ideal Rotary Pump Rotors

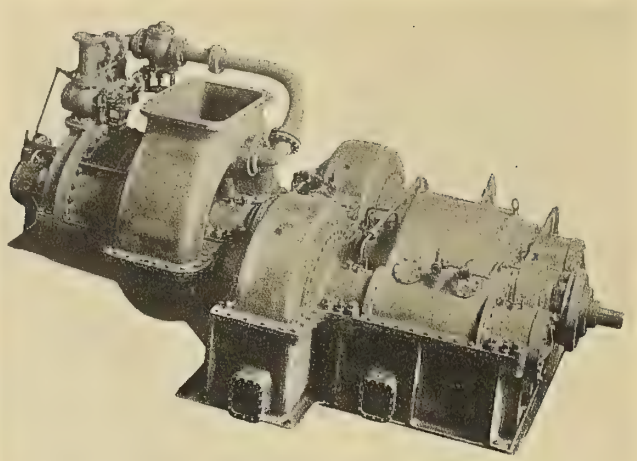


Fig. 5.—Assembled Reduction Gear—Turbine 2,600 Shaft Horsepower

for handling highly viscous oils, molasses and creosote, and are also fitted with a steam jacket for handling asphaltum. Each pump can deliver 350 gallons per minute against a total head of 350 feet at 200 revolutions per minute. The pumps are secured in the bottom of each compartment of the vessel, port and starboard to brackets that are integral with the tanks, and are driven by 40-horsepower, three-phase, 60-cycle, 220-volt motors. The discharge line for the three small tanks forward have nine 4-inch discharge gates, while the separate discharge line for the remaining tanks have fourteen 6-inch discharge gates.

The motors are located on the upper deck contained in a watertight and gas proof casing. The drive to the pumps is through a set of bevel reduction gears and a vertical shaft which transmits the power through flexible couplings to the pumps. The shaft is entirely enclosed in a casing which serves as an oil reservoir, so that all of the shaft

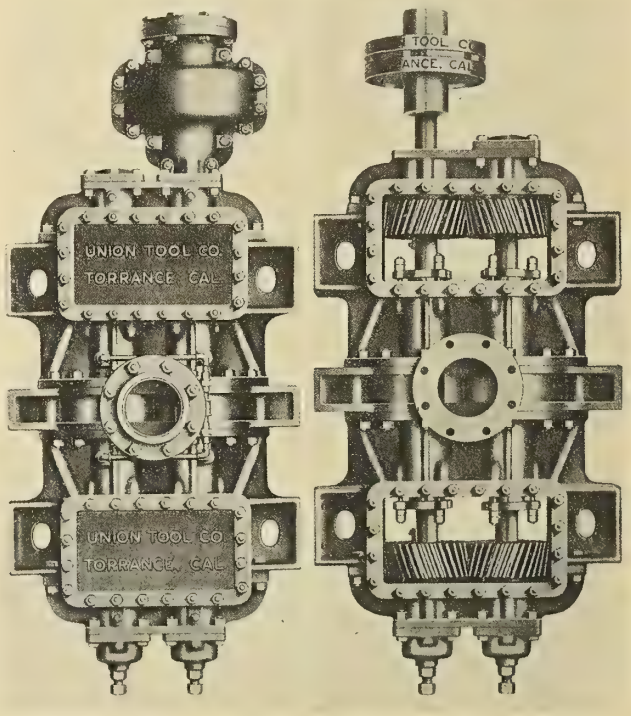


Fig. 6.—Exterior and Interior Views of 4-Inch Ideal Rotary Pump

bearings and the pump gears are all operated in an oil bath.

The pumps are each fitted with enclosed carbonized spiral gears, top and bottom, and operated with a minimum of noise. The vertical-drive shaft is hung on a ball thrust bearing contained in the gear case. They are fitted with 6-inch suctions and 6-inch discharges, so arranged that each pump can take suction from either or both compartments, port and starboard, at the same time, or independently. Cargo may also be discharged with one pump

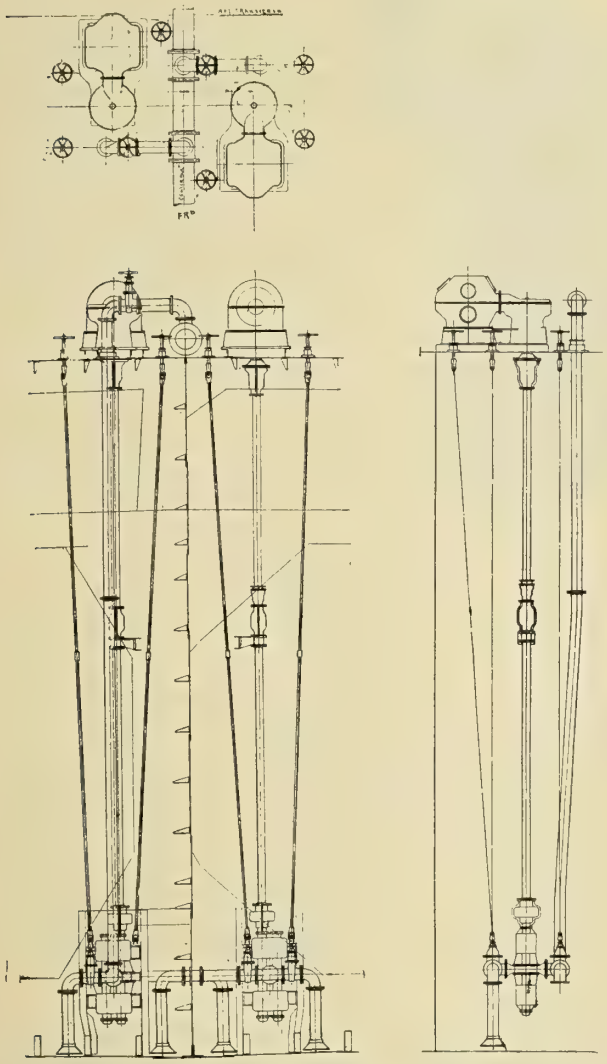


Fig. 7.—Details of Pump Installation, Showing Location of Pumps, Driving Motors and Method of Driving

or as many pumps as can be put into operation at one time, depending entirely on the capacity of discharge pipes to the shore tanks. Any number of commodities can be discharged at the same time without mixing, depending, of course, on the number of discharge lines that are available to the shore tanks. The discharge lines from the pumps are so arranged that they can be also used as filling lines to each individual tank, by means of a bypass around the pump.

All operating valves are located on the upper deck. The motor control for starting the pumps is located in the main engine room, and when it is desired to start any particular pump the deck officer gives the signal to the operator in the engine room. Pumps are thus under direct control at all times by the engineer on watch.

Since the *La Brea* went into commission she has handled

TABLE I.—*S. S. La Brea.*

Voyage	Date	Distance	Average speed per hour	Delivered	Port	Fuel used steaming on voyage	Per knot steaming	Used in port	Per knot steaming and in port	Time in port	Discharged per hour	Cost*
		Knots	Knots	Barrels		Barrels	Barrels	Barrels	Barrels	Hours	Barrels	
1.....	Mar. 9 to Mar. 15	650	9.5	62,578	Oleum	574	.883	142	1.10	36½	1,714	.880
2.....	Mar. 15 to March 26	2,037	11.33	73,600	Seattle	1,459	.716	152	.790	37½	1,962	.632
3.....	Mar. 28 to Apr. 6	2,108	11.01	64,676 8,642	Vancouver Seattle	1,584	.751	155	.824	28 13½	2,487 640	.659
4.....	Apr. 8 to May 16	9,254.5	10.97	52,109 9,045	Taltal Antofagasta	6,896	.745	117	.757	33¾ 15½	1,544 1,228	.605
5.....	May 17 to May 23	450	11.2	77,292	Oleum	321	.713	134	1.01	39	1,980	.808
6.....	May 24 to July 1	9,196.5	10.65	71,824	Antofagasta	6,900	.750	109	.762	25	2,860	.609
7.....	July 1 to Aug. 9	9,184	10.39	71,791	Antofagasta	6,875	.748	107	.760	31	2,316	.610
Total	.....	32,880	10.72	501,557		24,609	.748	916	.776	.....	2,418	.621

*At 80 cents per barrel per knot steaming and in port (full).

TABLE II.—*S. S. Los Angeles.*

Voyage	Date	Distance	Average speed per hour	Delivered	Port	Fuel used steaming on voyage	Per knot steaming	Used in port	Per knot steaming and in port	Time in port	Discharged per hour	Cost*
		Knots	Knots	Barrels		Barrels	Barrels	Barrels	Barrels	Hours	Barrels	
1.....	Apr. 9 to Apr. 15	423	9.4	67,074	Oleum	556	1 31	164	1 70	64½	1,039	1 36
2.....	Apr. 16 to Apr. 25	1,845	10.13	74,739	Vancouver	1,656	.897	218	1.01	33¼	2,214	808
3.....	Apr. 27 to May 25	6,549	10.22	73,734	Panama	5,579	.851	169	.877	46¾	1,577	701
4.....	May 26 to May 29	220	9.1	72,592	Oleum	221	1.00	123	1.56	41	1,770	1 24
5.....	May 30 to June 27	6,348	10.6	72,538	Balboa	5,462	.860	159	.885	35	2,072	.708
6.....	June 29 to Aug. 7	9,151	10.24	71,007	Antofagasta	8,293	.906	186	.926	56¾	1,261	.741
Total	.....	24,536	9.95	431,684		21,767	.887	1019	928	.....	1,556	.723

*At 80 cents per barrel per knot steaming and in port (full)

over 500,000 barrels of oil, and in each case the discharge was completed with a material saving in time as compared with vessels with ordinary pumping system.

The capacity of the pumping system is, of course, regulated by the capacity of the discharge lines and the pressure that the pumps are subject to. On a low-discharge head, and with ample shore connections, the entire cargo could be discharged in approximately 10 hours' time. The maximum quantity of oil handled per hour against a pressure of 110 pounds per square inch is reported to be 4,200 barrels.

The economy in fuel saved with this pumping installation appears to be approximately 45 percent over the ordinary manner of discharging a liquid cargo.

The data in Tables I and II have been compiled from logs on voyages to date, respectively, for the *La Brea* and *Los Angeles* and give a very good general idea of the

TABLE III.—*Voyage 7, S. S. La Brea Compared with Voyage 6, S. S. Los Angeles.*

	La Brea July 1 to August 9	*Los Angeles June 29 to August 7*
Total distance steamed in knots	9,184	9,151
Average knots per hour throughout voyage	10.39	10.24
Average revolutions per minute	85.75	65.94
Average vacuum	28.61	26.72
Steaming time loaded and light	36 days, 16 hrs., 50 min.	37 days, 5 hrs., 6 min.
Fuel used steaming loaded and light	6,875 bbls.	8,293 bbls.
Fuel used per knot steaming	.748 bbls.	906 bbls.
Fuel used in port pumping	107 bbls.	186 bbls.
Fuel used steaming and in port	6,982 bbls.	8,479 bbls.
Fuel used steaming and in port per knot	.760 bbls.	.926 bbls.
Cargo discharged	71,791.13 bbls.	71,007 bbls.
Time discharging	31 hrs.	56 hrs. 17 min.
Average barrels per hour discharged	2,315.84	1,261.

	Per cent less	*Per cent greater*
Percentage less or greater fuel used steaming	17.09	20.6
Percentage less or greater fuel used in port	42.47	73.8
Percentage less or greater time in port discharging	44.92	81.5
Percentage less or greater fuel per knot steaming	17.43	21.13
Percentage less or greater fuel per knot steaming and in port	17.92	21.84

	Per cent greater	*Per cent less*
Percentage greater or less barrels pumped per hour	83.65	45.54

comparative performances of the two vessels and their equipment. The methods employed by companies in measuring oil into and out of a vessel sufficiently guarantee the accuracy of these data for general comparison.

Comparing the time in port discharging and barrels of oil discharged per hour for the first six voyages, the *La Brea* was in port 36.4 percent less time and discharged 55.4 percent more oil per hour than the *Los Angeles.* If we reverse the order it will be noted that the *Los Angeles* was in port 57.04 percent more time and discharged 35.67 percent less oil per hour than the *La Brea.*

By referring to voyage seven of the *La Brea* and voyage six of the *Los Angeles,* it will be observed that the destination in each case was Antofagasta, Chili, and that the Los *Angeles* preceded the *La Brea* by two days. Notwithstanding the *La Brea* had been out of dock a month longer than the *Los Angeles* and a greater time in warm water, it is stated that she could have overhauled the *Los Angeles* and discharged first had the contrary not been arranged.

Table III gives separately a comparison of these two voyages on which the weather conditions are reported as follows:

La Brea.—July 1 and 2, rough following sea; July 3 to 7, fine weather; July 8, rough; July 9 to 12, fine weather; July 13 to 22, strong head wind and sea; July 23 to 30, fine weather; August 1 to 9, strong southwest wind and sea.

Los Angeles.—June 29 to July 5, fine weather; July 6 to 10, fresh head wind and sea; July 14 to 17, strong head wind and sea; July 18 to 28, fine weather; July 29 to August 7, moderate head wind.

It will be noted that the *La Brea* consumed 17.09 percent less fuel steaming, 42.47 percent less fuel in port, 44.92 percent less time in discharging, 17.43 percent less fuel per knot steaming, 17.92 percent less fuel per knot steaming and in port, and discharged 83.65 percent more barrels of oil per hour.

Mono Marine CO_2 Recorder

Flue gas analyses in connection with the operation of marine steam boilers to determine the efficiency of combustion can be made either by hand or automatically. Hand instruments are cheap, but, as the name implies, they are operated by one of the engineers on watch, who enters the analyses into the log sheet. The human element is not always dependable, neither does the time and length of watch always permit regularity of taking analyses. For this reason the Mono Marine CO_2 recorder for flue gas analysis, which is illustrated herewith, and which is handled in the United States by F. D. Harger, 603 Park Row Building, New York City, will be of interest to marine engineers, as it has been designed solely for use on board ship.

The United States Navy Department has experimented extensively in the analysis of flue gases, and, as a consequence, hand instruments are to be found on every battleship in the United States Navy, and, in fact, such instruments have become a part of the standard naval boiler room equipment. Very careful tests have been conducted on sister ships of the same boiler capacity, tonnage, dimensions, etc., one vessel being equipped with an instrument for analyzing the flue gases, and the other not so equipped. On the ship equipped with the analysis instrument the consumption of coal at the end of the trip was found to be considerably less than that of the non-equipped ship. As a result of these tests, experiments with recording instruments were begun, but these experiments ceased when it was found that none of the instruments commonly used in stationary practice would stand hard sea service. The Mono Marine CO_2 recorder, however, has now been offered to the Government, and experiments will soon be conducted on the United States battleship *Nevada.* As a result, it is expected that a large amount of fuel can be saved on board the ship by use of these instruments, just as has been established by their use on shore.

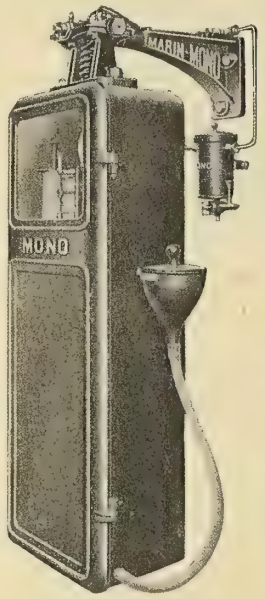


Fig. 1.—Marine Mono, with Moisture Regulator

As shown in Fig. 1, the Mono CO_2 recorder is suspended in a universal joint to permit the instrument to follow the movement of the ship as well as to counteract the bad effects of vibration. Fig. 2 shows part of a record, including a CO_2 as well as a CO diagram, both on one chart, made by the Mono apparatus. It will be seen that a very clear and even record has been obtained. Four of these Monoxide-CO_2 recorders have been installed on board of the S. S. *Kristianiafjord,* and, judging from the fact that the owners of the vessels, the Norwegian-American Line, placed the vessel in operation six months ago with one recording instrument on board and has since installed three more instruments, it is evident that the recorders have been successful and have attained the savings that were claimed by the manufacturers.

In this particular case, the furnaces of the boilers were equipped with Wager bridge walls, as manufactured by Robert H. Wager, 149 Broadway, New York. It was found that with a high percentage (from 11 to 12 percent) of CO_2 carbon monoxide to the extent of one percent was present, resulting in fuel loss, while, on the other hand, with Babcock & Wilcox watertube boilers, when the CO_2 averaged around 10 percent hardly any monoxide was present, indicating ideal conditions of combustion. In this way the firemen learned just what percentage of CO_2 to carry, something which could not be learned without an instrument recording the percentages of CO_2 and CO.

Figs. 4 and 5 show two views of one of the furnaces. Fig. 4 shows the appearance of the firebrick bridge after a run of 4,000 miles, indicating considerable fuel loss due

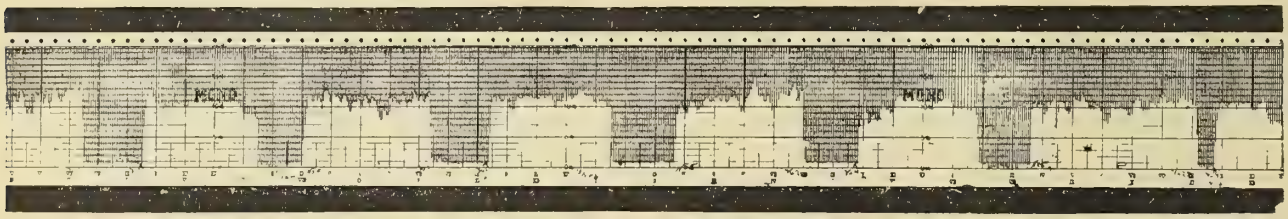


Fig. 2.—Part of Record Made by Mono Apparatus, Showing CO_2 and CO Diagrams

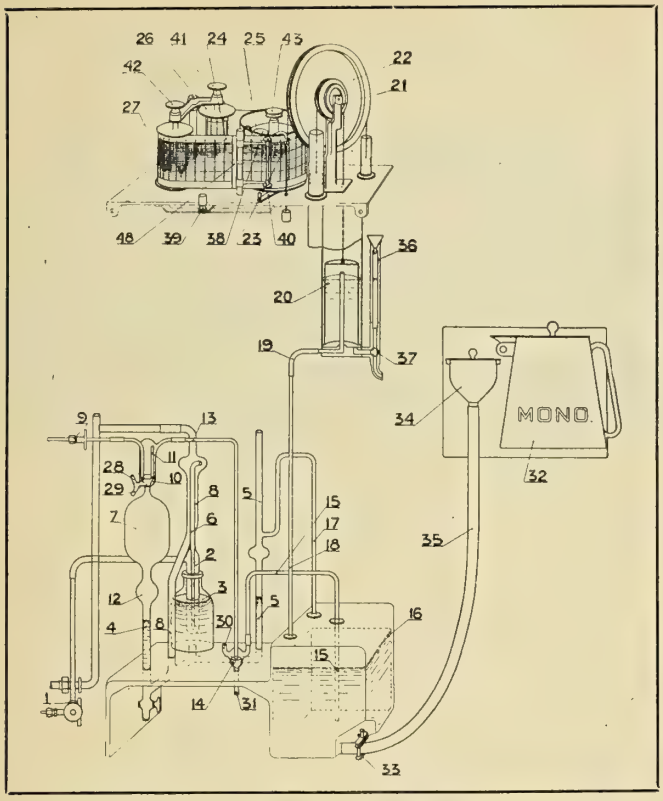


Fig. 3.—Diagram of Apparatus

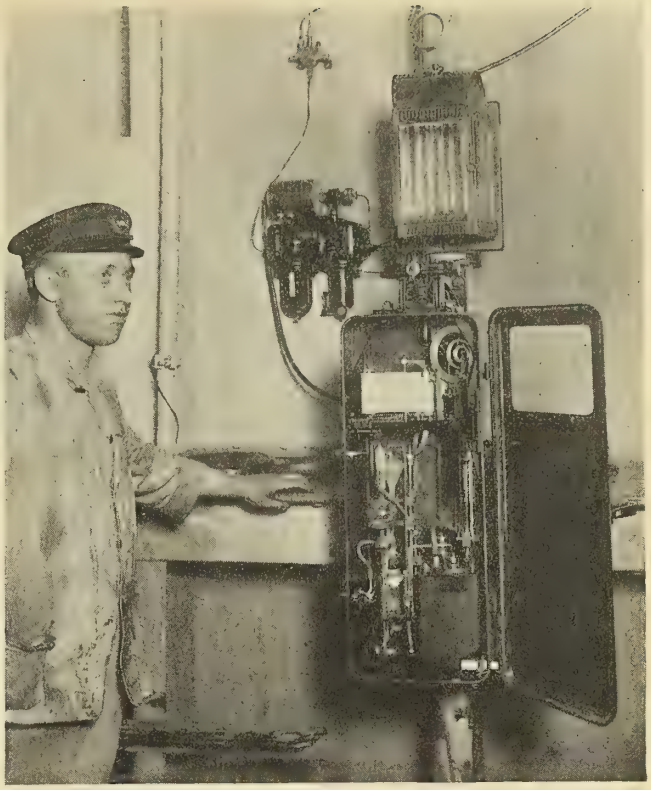


Fig. 6.—View Showing Interior of Recorder

to the presence of monoxide, forming on account of lack of air. Fig. 5, on the other hand, shows the Wager bridge in position, and from the records given by the CO_2 recorder it is easy to see how well it serves the purpose, as its design allows for the entrance of additional air to mix with the products of combustion, thus giving almost complete combustion of the fuel. The photograph shows no traces of deterioration after a run of 40,000 miles.

The proper distribution of air is what is indicated by the Mono apparatus; for, as is well known, combustion is a chemical process, during which a certain amount of oxygen combined with a suitable proportion of carbon under high temperature results in the formation of CO_2 gas. If at all times the amount of this gas present in the flue gas is known, it is evident that the conditions of combustion are in no sense a matter of guesswork, but, on the other hand, there is available a complete and reliable "tell-tale" record by which to fire the boilers.

The Mono recorder operates as follows: The absorption apparatus is mounted in the lower part of the cast-iron cabinet, to which it is fastened by means of three screws in the bottom. The pressure medium (water or air) by which the apparatus is driven passes through the regulating valve 1, Fig. 3, and the pipe, 2, into flask 3, which contains mercury. This is compressed up into the pipes 4, 5, 6 and 8.

Pipe 4 is at the top connected with the burette, in which

(*Continued on page 74.*)

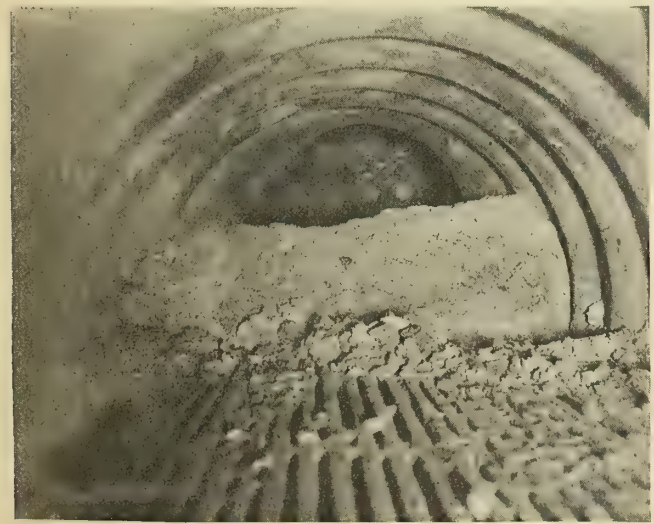


Fig. 4.—Appearance of Furnace After 4,000-Mile Run Before Equipment Was Installed

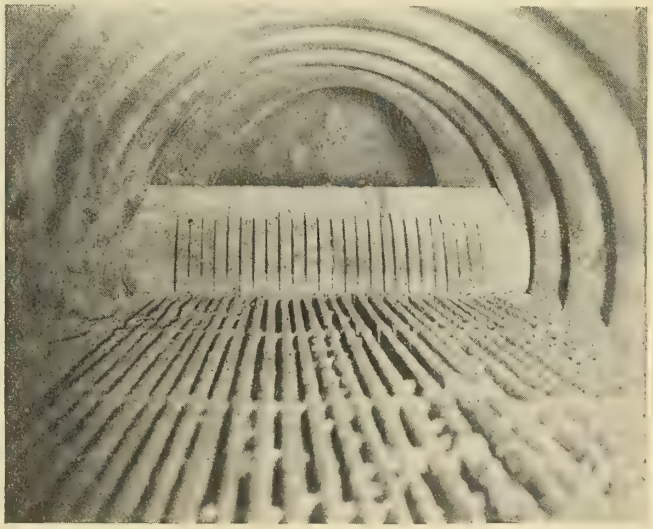


Fig. 5.—Condition of Furnace After 40,000-Mile Voyage, with Wager Bridge Wall and Mono Apparatus Installed

TURBINE STEAM YACHT WINCHESTER---TRIAL SPEED, 31.56 KNOTS

Built by Bath Iron Works, Bath, Me.

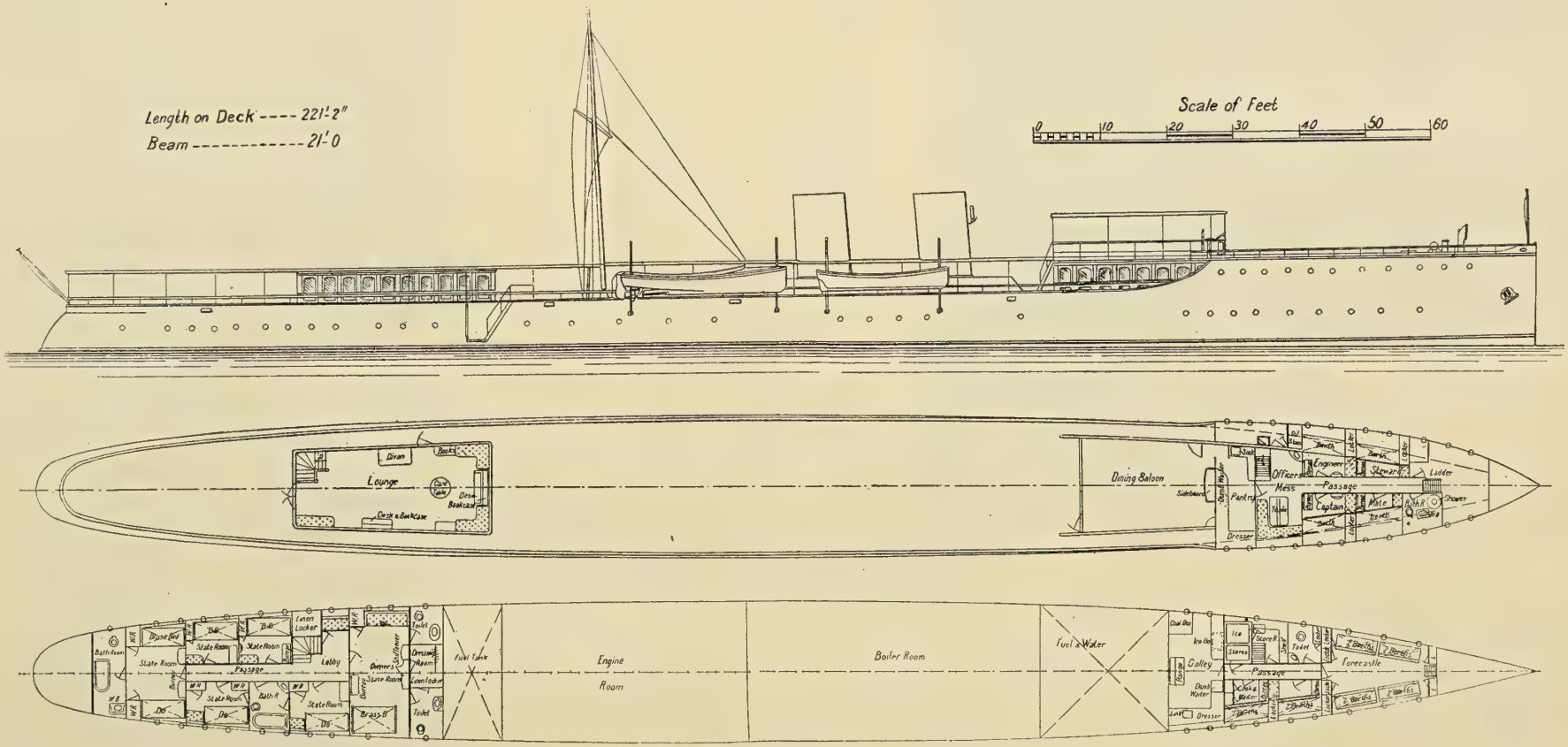


Fig. 1.—S. S. *Winchester*—General Arrangement Plans

Fig. 2.—Steam Yacht *Winchester* on High-Speed Run, Trial Trip, Showing Thin Bow Wave

Turbine Steam Yacht Winchester

Main Particulars and Trial Data of 30-Knot Yacht Designed by Cox & Stevens

BY E. A. STEVENS, JR.

THE steam yacht *Winchester* is the fourth vessel built for Mr. P. W. Rouss to bear that name. Like all her predecessors, she was built primarily for speed, but is considerably larger than her predecessors; in fact, she is the largest high-speed steam yacht ever built.

The *Winchester* is a twin-screw vessel, fitted with Par-

* From a paper presented before the Society of Naval Architects and Marine Engineers, New York, November 16.

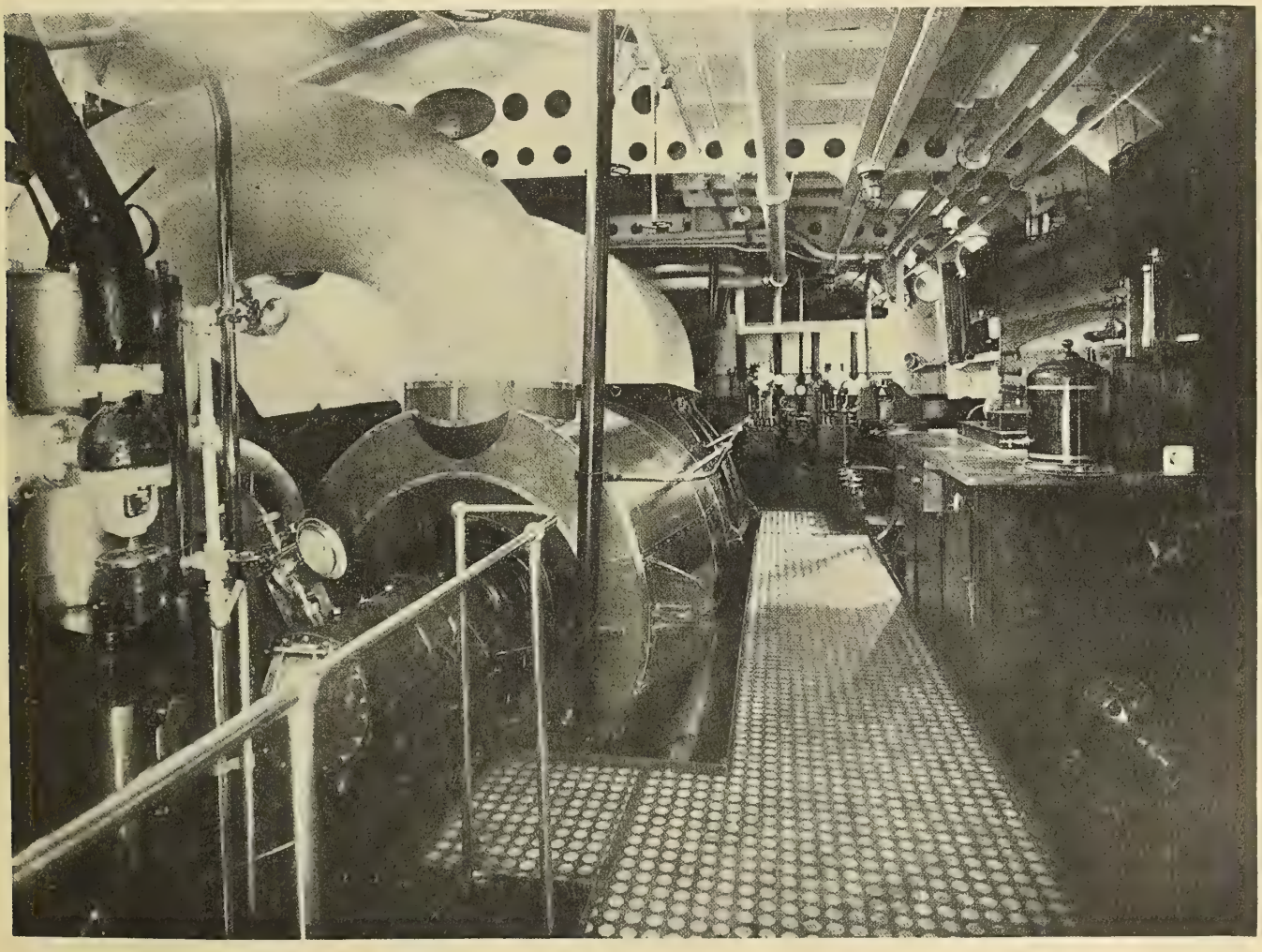


Fig. 3.—Steam Yacht *Winchester*. Interior of Engine Room

sons turbines and designed for a speed of 29 knots at about 360 tons displacement, with the main engines developing about 7,000 shaft horsepower. The vessel was built by the Bath Iron works, of Bath, Me., from designs furnished by Cox & Stevens, of New York City.

Hull Data.—

Length overall	225 feet 0 inches.
Length, load waterline	224 feet 0 inches.
Beam extreme	21 feet 0 inches.
Beam, load waterline	20 feet 8 inches.
Draft on trial	4 feet 11¾ inches.
Displacement on trial	322 tons.

The hull is built of high-tensile galvanized steel of substantial scantling; her plating is 11 pounds amidship to 8 pounds at the ends; the shear strake, from 13½ pounds to 8 pounds, while the keel is from 12 pounds to 10 pounds. The frames are correspondingly heavy, spaced 21 inches apart. From the above it can be seen that, although high speed was desired, strength was not sacrificed. She has been given several severe tests this last summer and has yet to show a weak place. She has also proven herself to be very able, as well as comfortable, in a seaway.

As can be seen from the plans, she has plenty of accommodation for both owner and crew, in spite of the large space given up to engines and boilers.

Propelling Machinery

The boiler equipment consists of two Normand water-tube, express-type boilers with 8,184 square feet total heating surface, and each is fitted with eight oil burners of the mechanical atomizing type. The maximum pressure allowed is 260 pounds per square inch, although this pressure is never used, 31½ knots being obtained with only 225 pounds, at the high pressure turbine.

The propelling machinery consists of Parsons turbines arranged on two shafts, the high pressure turbine being on the starboard, while the low pressure with the astern turbine is on the port shaft. These were designed for 7,000 shaft horsepower at 900 revolutions per minute, and are of the following dimensions:

	H. P. Turbine, Inches	L. P. Turbine, Inches
Length of rotor	82	57 9/16
Diameter of rotor	32	42
Rows of moving blades	54	26

The thrust bearings are forward of the turbines and are of the Parsons type.

Main Condenser.—There is one main condenser of 4,163 square feet cooling surface. The construction is similar to those that have been put into destroyers built by the Bath Iron Works. The section is circular and contains 2,832 ⅝-inch tubes. The tubes are bent to a curve to allow for expansion, and the ends are rolled into the tube sheets, which are not parallel. A vacuum augmentor of the Parsons type is also provided.

Propellers.—There is one three-bladed outboard turning propeller on each shaft, of manganese bronze cast solid. The blades are true screws, machined to pitch, and polished. The following are their dimensions:

Diameter	55 inches.
Pitch	51 inches.
Projected area	1,422 square inches.
Projected area ÷ disk area	.60

Auxiliaries

The various pumps are shown in the following table:

No.	Pump.	Make and Type.	Size.
1	Main air	Warren	10″ × 22″ × 16″
1	Main feed	Warren Simplex	13″ × 9″ × 14″
1	Auxiliary feed	Warren Simplex	13″ × 9″ × 14″
1	Main circulating	Centrifugal 12″ suction and discharge engine	7″ × 5″
1	Fore and bilge	Warren Simplex	4½″ × 5½″ × 6″
2	Lubricating oil	Warren Simplex	2½″ × 4″ × 6″
2	Fuel oil	Warren Duplex	4½″ × 3″ × 12″
1	Fresh water	Centrifugal driven by electric motor	
1	Salt water	Centrifugal driven by electric motor	
1	Sanitary	Warren Simplex	3½″ × 5″ × 6″

The other auxiliaries consist of the following:

Feedwater heater of 248 square feet.

Fuel oil heater, 75 square feet.

Lubricating oil cooler, 63 square feet.

Two forced-draft blowers driven by Terry turbines.

Electric outfit consisting of a 10-kilowatt, direct-current generator driven by a Curtis turbine.

A special type of steering engine made by the Hyde Windlass Company, with two cylinders, each 4 inches by 4 inches.

A Hyde steam windlass with two cylinders, each 4 inches by 4 inches.

Trials

The trials were run in smooth water over the Government course off Rockland, Me. Twelve runs in all were made, with the following results:

Run	*Direction.*	*R.P.M. Mean*	*Estimated S.H.P.*	*Speed in Knots.*
1	N	1014.5	7020	30.38
2	S	1031.0	7360	32.11
3	N	1032.5	7580	30.98
4	S	1035.0	7485	32.09
5	N	1035.5	7360	30.90
6	S	1038.0	7470	32.32
7	N	713	3272	23.92
8	S	697	3194	24.83
9	N	497	1155	17.22
10	S	540	1320	19.87
11	N	295	269	10.21
12	S	287.5	206	11.21

After the progressive trials a two-hour run was made, on which the oil consumption was measured by sounding the fuel oil tanks. The speed obtained was 19.7 knots, and the oil consumed was 669 gallons. Taking the shaft horsepower from the curves at 1,840 and assuming a specific gravity of .88 for the oil, this would give about 1.35 pounds of fuel per shaft horsepower per hour.

In the picture shown in Fig. 2, which was taken during one of the high-speed runs, the bow wave is not very high and consists of a very thin sheet of water, as the painted water-line on the ship's sides can be plainly seen through it. The trim of the vessel at this speed is changed very little from that at rest. Had more power been supplied, no difficulty would have been experienced in obtaining very much higher speed; this is substantiated by the tank trials of the model.

A comparison of the preceding yachts bearing the name of *Winchester* with the present one is shown in the following table:

Turbine Steam Yacht "Winchester"

	Winchester No. 1	*Winchester No. 2*	*Winchester No. 3*	*Winchester No. 4*
Present name	Adroit	Flying Fox		Winchester
L.W.L.	140′ 0″	165′ 0″	205′ 0″	224′ 0″
Beam	15′ 6″	16′ 0″	18′ 6″	21′ 0″
Trial draft	5′ 0″	3′ 10¾″	3′ 11½″	4′ 11¾″
Trial displacement	150 tons	136.3 tons	207.5 tons	322 tons
Machinery	Reciprocating	Parsons turbines	Parsons turbines	Parsons tur.
No. of propellers	2	3	2	2
Horsepower	About 1500 I.H.P.	About 3000 S.H.P.	About 7000 S.H.P.	8074 S.H.P.
Speed	About 20 knots	26.516 knots	32.24	31.56

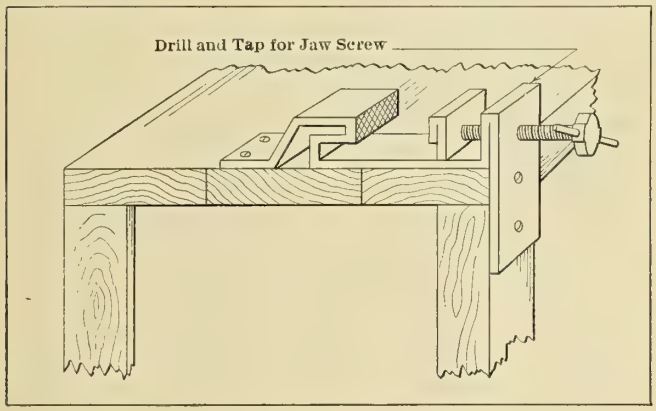
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Bench Vise

The need of an extra vise on the bench is apparent when you have a lot of overhauling or refitting to do. There is one lying in the stock rack, or scrap pile of every ship. All you need to do is to put it together, as shown in the illustration. It can be made almost any size (mine is made



Improvised Bench Vise

out of 3-inch by ½-inch flat bar stock). It is pretty handy for filing up bearing liners, rethreading bolts and nuts, etc. It saves time waiting for the other fellow to get through using the big vise. C. H. W.

Laying Up Boilers

Perhaps a few notes on laying up boilers might be helpful to some of the readers. Too little care is generally given to this important work. I fully believe a boiler can deteriorate as fast when idle, if not laid up properly, as it will in active service. A little money spent on the boiler at the time of laying it up will save a lot of money when it is to be put back into service again.

Laying up a boiler generally means a period of from three to six months that it will not be used. It is always best to empty the boiler and wash it out thoroughly, being sure to get the mud and sediment all out. Thoroughly dry out the interior surfaces by circulating hot air from fires built close to the bottom manholes, leg handholes, or mud drums, according to your type of boiler. Remove the top manhole plate of the steam drum and place a small electric fan just inside to drive the air out. Of course a portable blower is best, if one is available.

Small pans of fire can be set in the lower or upper drums if the openings will permit. The main thing is to get the interior absolutely dry, and the next to keep it dry. After inspecting the interior and being satisfied that it is dry, set pans of unslacked lime in the upper and lower parts. Do not put any on the metal of the boiler, and be sure to use containers. This lime absorbs the moisture that might be left.

Secure all handhole or manhole plates, and all cocks and valves, making sure that the boiler is absolutely air tight. Break any feed line or other line joints that might connect with the boiler that have any pressure on them and blank them off. Make sure that all valves, try cocks and water columns are tight, and wire them shut against mischievous hands.

Clean and paint with red lead all external parts of shell, or headers, and patch the casing to prevent water leaks from rusting the outside of the shell. Make sure that no ashes or dirt are left around to hold the moisture near the boiler; if a watertube boiler, wipe all tubes outside that you can reach with graphite and thin oil; if a flue type, push a swab through. Apply this graphite wash to all external parts that cannot be red leaded.

It pays to clean thoroughly the fireside of all soot, for soot collects moisture and this means rust.

Boilers that are laid up should occasionally have a small wood fire built under them to dry the moisture that might collect. Take some steps to prevent rain coming down the stack or uptake, to which idle boilers are connected.

Boilers that are to be idle for but a few weeks should be kept full of fresh water of about one-half percent alkaline strength, and under a pressure of about 25 pounds, making sure to expel all air. Do not forget to slush the safety valve parts with oil or vaseline. W.

"Safety First" Kink

The floor plates at the foot of the engine room ladders on board ship were of the straight-rib design, as shown in Fig. 2. The ribs ran in the same direction as the traffic that passed over them. Constant wear had worn these smooth; this, combined with the oil and grease (which is ever present in all engine rooms, even after they are wiped

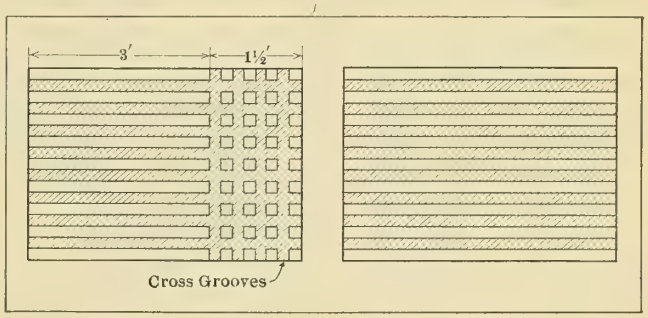


Fig. 1 Fig. 2

down), makes them slippery and dangerous, especially during rough weather. To cure this trouble, at the base of the ladders I cut cross grooves in the plates for about 1½ feet of the plate, as shown in Fig. 1, using an air hammer and round gouge chisel.

I like the result so well that I shall change the floor plate near the engine throttles in the same manner. There are plates of this pattern on the market, but I have never seen any used on board ship for floor plating. I think perhaps the reason is that it is harder to keep this pattern of plate clean when the grooves run both ways of the plate, but the tread is much safer. GRATING.

Kink for Making Bearing Liners

Recently when overhauling some machinery that included relining some bearings with babbitt metal I was at loss for some liner material to take up the distance between the bearing cap and bottom brass.

The required liner needed to be about 3/16 inch thickness. This was too much space to fill full of thin liners, and not having any brass sheet of this thickness or other suitable material on hand I hit upon the following idea:

Some short pieces of ½-inch and 1½-inch brass pipe were lying in the scrap pile. This I took and split lengthwise, and after annealing flattened this out, and a little dressing with a file gave me plenty of liner material. Various size pipe will give the different thicknesses required for most any large bearing.

This kink is handy on shipboard, where sometimes the scrap pile in the old storeroom is a labor saver.

CHIEF.

Valve Troubles and Some Cures

There probably is not a steam power plant engineer in existence that has not been confronted with the frozen valve stem trouble. We've all had more than one or two of these disagreeable out-of-the-way valves that were opened and shut only once in a while, and finally, just when they were needed to cut a section of the line, or to by-pass something, they would not budge, even with a good-sized monkey wrench used as a leverage on the hand wheel. This generally twisted the stem off or twisted it so badly that a new one had to be made in the shop.

My plan when I find a valve with the stem frozen in the yoke, or one that works so stiff that the use of a wrench to move it is required, is to take a gasoline torch, heat the yoke around the stem, tap good blows with a suitable hand hammer and keep persuading the stem to move back and forth, using fine strips of emery cloth to clean the threads close to the yoke, blowing the dirt away before entering the cleaning part into the yoke. Patience is required for this work, especially if the valve is located in an uncomfortable place.

When the stem fails to move after trying the heating as above mentioned, there is but one other method that I know of to try. This is to take the valve bonnet off and to remove the disk; then tap the ends of the valve stem in addition to the yoke. Secure the bonnet in a vise, or, if the valve is too large, clamp it to some angle plate. A pipe wrench can be used on the part of the stem next to where the disk was secured, and the hand wheel and another wrench can be used on that part of the stem above the yoke. This method gives the power to move, yet divides the twisting strain between both ends of the stem. This, of course, can only be done if you are able to take the valve apart, having no pressure to deal with.

After getting the troublesome stem out and cleaning the threads of the stem and yoke, if you cut a slot similar to a keyway down through the threads on one side of the stem, this will always clean the threads out each time the valve is used and it does not weaken the stem enough to do any harm. I have tried this on more than twenty different size valves and it works splendidly.

Many times a steam valve is closed so tightly that it seems like the stem is frozen, when really all that is wrong is that the valve has been jammed shut and the line temperature changed so that it has contracted the parts of the valve, and thus set the valve disk tighter on the seat. When a valve is found in this condition the yoke through which the stem works can be slacked away enough to ease the strain and then the stem can be moved.

When the valve is one in which the yoke cannot be slacked away from the bonnet or bonnet studs on account of its design, the best thing to do is to slack the bonnet away at the flange. Of course this means that the pressure on the valve must be taken off first.

These methods will save considerable damage to the valves if you have a little patience. C. H. W.

Feed Water

There are many little installations of pipes and fittings for saving the drains and drips of fresh water about the plant on board this ship that I think have well paid for their cost of installation, and perhaps some other engineer might be able to save a few dollars on feed water by following the same plans, where possible, on board his ship.

Our feed or filter tanks are of 3,500 gallons capacity, one in the starboard and one in the port engine room. The discharge of all auxiliary and main air pumps is led into the top of these tanks; also two drain lines, one from the discharge of the various steam traps, and the drain line from the cylinders of the auxiliary machinery. These drains all enter the tanks at about 4 feet from the bottom and are led well into the tank by internal distributing pipes. This effectively heats the water to about 180 to 190 degrees. The main feed pumps can be supplied with water either direct from these tanks or by the hot well or lift pumps. The lift pump is always used, for its suction is below the bottom of the feed tank and it takes water of 190 degrees and delivers it through a feed heater to the suction of the main feed pumps at 230 to 240 degrees.

Our make-up or extra feed water is carried in reserve double bottom compartments. These compartments are connected to the suction of the lift pumps. Between this suction line to the bottoms and the suction to both main air pumps we have installed a two-inch pipe line with a globe valve next to the air pump end. This line is used when the ship is underweigh to keep the supply of feed water in the feed tanks at about 3,000 gallons. By regulating the opening of the globe valve next to the air pump it will by means of the air pump vacuum draw from any bottom a slow, steady supply of extra feed and deliver it to the feed tanks without knocking down the temperature of the feed water or destroying the vacuum.

We have installed a 2-inch drain line pipe from the bottom of each safety valve escape pipe, leading these to the nearest reserve bottom filling line. These save an untold amount of water when the valves are blowing. Also the atmospheric exhaust and the vapor pipes from the hot well are connected to one of these escapes so that this increases the saving.

The drains of all auxiliary machinery are led to the hot wells in a separate line. At the throttle valve of each pump and piece of machinery on the steam line side of the valve the body is drilled and tapped for ¼-inch pipe, and this fitted with a globe valve and ¼-inch piping to drain the accumulated water into the drain line before starting, saving a great deal of water being forced through the machinery and out through the rod packings. It also affords a means of draining the steam line to the pump or machinery when the root valve is closed at the main steam line. It is a rule in this plant that when a piece of machinery is put out of use its root valves be closed in addition to valves on the piece of machinery.

The discharge of all relief valves of feed pumps is led either into the suction chambers of the pumps or to the feed tanks, and, if possible, and too much piping is not required, they are led when possible to the nearest reserve

bottom. The reason that I speak of this is that when the relief valves discharge into the suction chambers there is generally some trouble experienced with the pump losing its suction. This is due to the water in the suction chamber being forced out by the air that collects in the short section of pipe connecting the relief valve to the suction chamber. This makes the pump air bound. It is also thought that the water being discharged at a high pressure and velocity helps to cause these troubles.

Often it becomes necessary (when some pump or steam line is disabled) to shift the water from one boiler to another or one tank to another, etc. If air compressors are on board this can be easily accomplished by placing an air pressure on the boiler or tank, say about 50 or 60 pounds. This will displace the water to most any place desired. Portable steam siphons are very handy for drying out double bottoms below the pump suctions, saving a lot of bailing of water when it becomes necessary to dry the bottoms for painting.

Recently on a trip of some 6,000 miles we had one of the tube sheets of the starboard main condenser spring a leak, and as it was pretty bad weather the skipper ordered the chief to continue steaming until we had better weather before he would let us stop the starboard engine. This leaking of salt water continued for two days, and the result was that the eight boilers and both feed tanks were run up to about 500 to 600 grains of salt per gallon. (This was some 30,000 gallons of water.) The boilers were of the Babcock & Wilcox watertube type, so it was urgently necessary that further steaming with high saturation be stopped as soon as possible.

Just as soon as we were able to stop the starboard engine the chief decided to save the water, so fires were lighted in four new boilers, and the fires allowed to die out in four of the salted ones. The speed was reduced to 5 knots with one engine, and the water of the starboard feed tank emptied into an empty reserve bottom, then refilled with fresh water. As soon as the four new boilers were cut in they were fed from the fresh water in the starboard tank and the remaining four salted boilers cut out. The water of the port feed tank was then emptied in the same bottom as the starboard tank and refilled with fresh water. This gave us four new boilers steaming and feeding with fresh water.

Four of the salted boilers were next run into a reserve bottom and refilled with fresh water, and as the work on the condenser was nearly finished they were started, and soon we were again at standard speed.

We then looked at the evaporator log and selected the cleanest evaporator and re-evaporated the 30,000 gallons of salted water, first taking that from the bottoms that we had filled and next that in the remaining four salted boilers. The water was supplied to the evaporator feed pump by pumping it up there through a few lengths of fire hose, as there was no regular run of piping that we could use.

The chief figured that he saved some coal in doing this stunt, for it was forced through the evaporator at a high rate of evaporation and it did not leave as much salt scale on the coils of the evaporator as the evaporating of that much sea water would have, therefore not using as much steam.

Economy.

Norwegian Shipping Losses.—The total war losses in the Norwegian merchant marine up to November 30, 1916, according to recent Consular reports, have been 242 vessels of 325,415 gross tons. Of these vessels 182 were steamships of 281,628 gross tons.

Delivery from Centrifugal Pumps

In the November issue an article of mine dealing with feed pump valves drew attention to the fact that centrifugal pumps were usually designed upon a velocity basis of 10 feet per second.

The exact velocity basis of any centrifugal whose revolutions are known can be easily obtained during overhaul. All that is needed is a tape measurement round the circumference of the impeller in feet and decimals. Multiply this length by the revolutions per minute and dividing by 60 gives the velocity in feet per second.

$$\frac{\text{Circumference in feet} \times \text{revolutions per minute}}{60} = \text{velocity, feet per second.}$$

In a case where the revolutions are unknown these may be obtained by the converse method of assuming 10 feet per second as velocity. The 10 feet multiplied by 60 to give a minute and divided by circumference of impeller in feet gives the revolutions necessary.

As a formula:

$$\frac{60 \times \text{velocity in feet per second}}{\text{Circumference in feet}} = \text{revolutions per minute.}$$

As examples a 15¼-inch diameter impeller with a circumference of 48 inches should run at 150 revolutions per minute, while a 7⅝-inch diameter impeller needs double the revolutions (300) per minute.

It is necessary in the case of centrifugal pumps to rid the mind of the question of displacement, and for this reason the centrifugal presents a little difficulty in comprehension to many practical men. In a high-lift centrifugal in stages, for example, the step up is not in pressure, but in velocity. Hydraulic engineers have no such difficulty, as even in a reciprocating pump the term head (expressed in feet) is more usual than that of pressure.

Velocity and pressure are interchangeable terms in the vocabulary of the hydraulic expert, and the boiler-feed injector and the centrifugal pump have a basis in common —velocity—although imparted quite differently.

To understand the steam turbine it is necessary to get rid of the pressure-displacement idea altogether. If you imagine a man jumping onto a wheeled truck and by so doing his momentum moves the truck, it is an analogy practically perfect. Multiply the one man by thousands in quick and regular succession and it is obvious that the truck would have considerable velocity imparted. Now, this illustration is true for the injector; the centrifugal pump and the turbine, whether water or steam is the fluid dealt with.

The two main factors in hydraulic practice are velocity and friction—the first imparted by mechanical means, the second a loss whose amount is increased by faulty design. That velocity can be increased independent of further power is realized when the shape of the fire hydrant branch pipe is observed. By constriction of the outlet in a suitable manner the height of the jet thrown can be increased. The two factors here are the exact shape of the outlet and the constriction, which increases the velocity but diminishes the pressure just before the point of exit.

In a stage centrifugal the results are obtained with equal-sized impellers by the transference of velocity to pressure between each stage. The water is momentarily brought to rest between each stage and the velocity imparted by the succeeding impellers is given to water already under pressure, much in the same way that pressure in town mains is not lost when passed through a pump to give increased pressure.

As already stated, the outlet of a centrifugal pump can

be closed with impunity, and under these conditions less power is required.

The defects of a centrifugal are, first, that it is most economical under the conditions of designed head and speed. A reciprocating pump absorbs power proportional to varying head and speed, but while the power used with a centrifugal varies with the work done, its efficiency is badly impaired by alteration from its designed duty. The second defect is that it has no natural suction and must be primed to start. This makes the provision of a first class foot valve indispensable. Again, it is not unusual for a centrifugal to absorb more power, lifting as it does a much larger quantity with the lowest head. While at a constant speed the volume delivered varies greatly by alteration in head with a velocity pump, with a reciprocating pump under the same conditions the quantity remains constant under any head or pressure. The plunger or piston pump locks off successive determined quantities of fluid, the centrifugal varies its volume inversely as the head.

It is therefore important that the speed and head for which the centrifugal is designed be held constant, hence perhaps the value of a realization of the velocity basis upon which most centrifugals are based.

Under certain circumstances, no data being available, it, may prove useful to have a simple rule to estimate the quantity likely to be obtained from a velocity pump. If the diameter of the discharge pipe be measured and its area in square inches determined, this area multiplied by the constant 26 will give the gallons per minute Imperial. The area in square inches multiplied by the constant 31 will give the output in United States gallons. The relation between the two standards is variously expressed as 10 : 8⅓, 100 : 82, 30 : 25, or exactly 277.463 : 231.

As a formula:

$A \times 26 =$ 1 gallon per minute.
$A \times 31 =$ United States gallons per minute.
$A =$ area, always in square inches.

The errors in the results so obtained are very trifling. Imperial minus .2 percent, United States plus .38 percent, the exact results being 25.95 and 31.12, respectively.

The errors so introduced are not greater than that due to error in workmanship in the pump itself or in observation as to speed. The difference between 259 and 260 revolutions is greater than the error in the formula given. Timing revolutions with a stop-watch and speedometer is certainly less accurate than the results of the formulæ.

For any other velocity it is necessary to multiply by the factor introduced. For example, velocity is found to be 9.6 feet per second by measurement of impeller and revolutions. The area of a 12-inch discharge pipe is 113 square inches; multiplied by 31 this equals 3,503 U. S. gallons. If this result be now multiplied by .96, the correction for the lower velocity is easily made.

It is hoped that the constants given above may prove useful, while the attempt to elucidate some of the main features of the centrifugal pump may prove helpful to a minority, at all events, of readers.

London. A. L. HAAS.

ANNUAL MOTOR BOAT SHOW.—The Thirteenth Annual Motor Boat Show was opened in the Grand Central Palace, New York City, on Saturday, January 27. It will remain there until the following Saturday evening, and during that time yachting enthusiasts from all parts of the country will make their headquarters in the Grand Central Palace. During the week meetings will be held of associations organized for the benefit of the sport, and of the National Association of Engine and Boat Manufacturers, under whose auspices the show is held each year. Every inch of floor space has been taken and many large yachts are to be exhibited.

This year the show takes on a naval aspect. The decorations are blue and gold, the navy colors, and these decorations are very artistic. Because of the preparedness movement yachtsmen have of late been building boats that can be used as patrol or scout cruisers. The motor boat has proved its worth in the present war, and owners of boats are ready to help in case of hostilities with their craft, and they go further by building boats to conform to the types suggested by the Navy Department.

Two boats, 45 and 66 feet long, have been built to show what type is needed, and models of these boats have been made by the Boucher Manufacturing Company, which show them fully equipped.

Mono Marine CO_2 Recorder

(*Concluded from page 67.*)

the volume of the gas is ascertained. Pipe 5 is in communication with the outside air and the upper part of pipe 6 passes into an expansion of pipe 8, Fig. 3.

The lower part of pipe 6 passes into the bottom of a recipient, 2, and is thus only indirectly in connection with the mercury in flask 3. The position of this inner recipient, 2, in flask 3 is such that the mercury in pipe 6 will always rise higher than that in pipe 5 or 8, Fig. 3.

As the pressure is increased the mercury is finally forced out of the recipient 2 through pipe 6 and runs down into pipe 8, Fig. 3. As soon as pipe 6 is empty of mercury the pressure medium comes in contact with the outside air and the excess pressure in flask 3 disappears. The mercury in pipe 4 and 5 then runs back into flask 3, filling it until some of it finally runs into the recipient 2. By this means the lower outlet of pipe 6 is closed. The pressure medium is now no longer in contact with the outside air and the pressure rises again in flask 3, and the process above described is repeated. In this way an alternately rising and falling movement of the mercury is brought about, which movement is utilized in the following manner:

When the mercury sinks, as above described, the gas to be analyzed is drawn in from the funnel through the filter and the tubing to the absorption apparatus. Through the coupling, 9, the mercury seal, 10, and the pipe, 11, this gas then passes into the burette, 7, where it is measured, the pressure and temperature always being constant. When the mercury rises, the gas from the burette is compressed through pipe 13, the mercury seal 14 and pipe 15 into the recipient 16, which is filled with absorption liquid. The carbonic and sulphuric acid in the gas is here absorbed, the remainder of the gas being compressd through pipe 18 up in the gasometer 20, which is shut off from the outside air by water.

When the gas enters, the gasometer rises and turns the wheel 21, which in its turn finally acts on the wheel 22. On this wheel and connected with it by means of a metal pin hangs the pen 23, which draws the curve on the diagram paper 24. The lower extremity of the line produced indicates the percentage of gas absorbed.

When gas is drawn into the burette, pipe 17 comes in contact with the outside air, the gasometer then sinks back to its original position and the apparatus makes a new analysis and a new registration.

The method of suspending the instrument is clearly shown in Fig. 6. To the left, slightly above the instrument, will be found the Mono monoxide auxiliary which makes the analysis of CO possible. The marine type Mono apparatus is driven either by water or compressed air, whichever is more suitable to local conditions.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Formula for Critical Speed of De Laval Turbine

Q.—Will you please quote me a formula, if there is one, which will permit me to figure the critical speed of the shaft of a de-Laval turbine? S. D.

A.—Considering the bearing as supported, not fixed, in bearings equally spaced from the rotor, the following, given by Loewenstein, may be used:

$$R.\ P.\ M.\ \text{for critical speed} = 1{,}550{,}000\ \frac{d^2}{l \vee W l}$$

where d = diameter in inches; W = load applied; l = distance from $c.$ to $c.$

Size of Safety Valve for Air Compressor

Q.—Please calculate the size of the safety valve necessary for a two-stage air compressor delivering 130 cubic feet per minute at 110 pounds per square inch gage? C. A. P.

A.—Assume that the discharge temperature from the high pressure is 60 degrees F.

Using Reynolds'† formula for air to determine the effective area of the valve.

$$Q_1 = \frac{405\,A\,(P_1^2 - P_2^2)^{0.48}}{\vee T}$$

Q_1 = quantity of air discharged in cubic feet per minute at 32 degrees F. and 14.7 pounds per square inch absolute,
A = effective area, square inches,
P_1 = delivery pressure from high-pressure stage, pounds per square inch absolute,
P_2 = atmospheric pressure, pounds per square inch absolute,
T = absolute temperature of air from high-pressure stage.

$$\frac{P_1 Q_1}{T_1} = \frac{P_2 Q_2}{T_2}$$

$$\frac{144 \times 14.7 \times Q_1}{32 + 460} = \frac{144 \times 124.7 \times 130}{60 + 460}$$

$$Q_1 = 1043.\ \text{cubic feet.}$$

$$\text{Then } 1043. = \frac{405\,A\,(124.7^2 - 14.7^2)^{0.48}}{\vee 60 + 460}$$

A = .575 square inch.
Assume lift = .06 inch.

$$\text{Circumference} = \frac{.575}{.06} = 9.58 \text{ inches.}$$

Diameter = 3.05 inches.

*Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

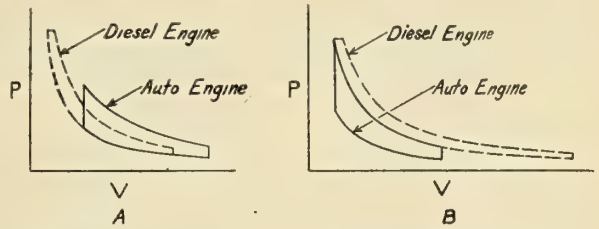
†"The Flow of Air and Steam Through Orifices," H. B. Reynolds, Journal of the American Society of Mechanical Engineers, 1917.

Constant Volume vs Constant Pressure Cycles

Q.—In view of the fact that the Diesel engine has proved so efficient and popular for marine practice, why has not it been developed for automobiles ashore? D. E.

A.—The Diesel engine is necessarily a much heavier unit in pounds per brake horsepower than the present type of automobile internal combustion engine, which works on the so-called "constant volume" cycle. The two cycles are given below and it is obvious that to do the same work for a given cylinder diameter and length of stroke the Diesel diagram must have the same area and therefore much higher pressure, or if we permit both cycles to have the same maximum pressure the Diesel must be much longer for the same cylinder diameter to produce the same power, and therefore will require a longer stroke and heavier engine.

The "constant volume" cycle receives its heat at constant volume by the ignition of the charge after compression and when the piston is practically stationary at the end of its stroke. The Diesel "constant pressure" cycle receives its heat by the injection of fuel during the early part of its working stroke and at such a rate that if cut off the pressure remains constant.



Comparison of the theoretical cycles of the automobile (constant volume cycle) and Diesel (constant pressure cycle) engines. As drawn all produce the same work per stroke for the same diameter cylinder.

This comparison is of fundamental cycles, and in addition to the disadvantage here shown is the auxiliary apparatus necessary for the Diesel unit.

Coal Bunker Measurement

Q.—How many cubic feet are allowed per ton in estimating the capacity of coal bunkers? C. B. M.

A.—Usually 44 cubic feet of bituminous coal, unless coal of a known character is to be used continuously, in which case the actual value of that coal should be used. With different types of coal it varies from 36 to 50. Mackrow* recommends for British Practice 40, derived from the Admiralty allowance (1 ton = 2,240 pounds).

Setting Valves to Triple Expansion Engine to Get Least Vibration

Q.—Please print in next month's copy of MARINE ENGINEERING the best way of setting valves on a triple-expansion marine engine to get least vibration, sequence of cranks, H. P., M. P. and L. P. R. E. C.

A.—The setting of the valves of any engine has no effect directly upon vibration, and as a premise to the act-

*The Naval Architects' Shipbuilders' and Engineers' Pocketbook by Mackrow and Woollard. The Norman W. Henley Publishing company, New York.

ual answer to your question, just a word about vibration. Vibration is due to the inertia effects of the reciprocating parts and unbalanced rotating members, and is not affected by the *steam forces* in the cylinder in any way.

Valve setting affects the *work done* in the cylinders and changes in setting only cause corresponding changes in the proportional part of the total work which is done in each end of each cylinder. If, however, there is a serious inequality in the work performed by each element it may result in gross irregularity of turning moment, therefore lack of uniformity of angular velocity and irregular motion of reciprocating parts. This would affect vibration, but very rarely is the irregularity so great, especially with multiple cylinder engines, and if sufficient appreciably to affect regularity of turning it would be very noticeable in the indicator diagrams.

It is desirable, however, that each end of each cylinder do an equal fraction of the total work and "balancing" an engine by the valve setting commonly means the attempt to obtain this equal distribution of work. In practice the problem is usually presented in one of the two following forms: (a) with full information from the drafting room as to the proper location of events and position of valve; or, (b) no information other than possibly indicator diagrams.

Case (a) is the simplest, and only involves a thorough realization that usually but two quantities are adjustable, length of valve rod and location of eccentric; and further that the effect of changes in the former is to vary the distribution of work between the head and crank ends of a cylinder and the effect of changes in the latter is to vary the timing of the events, but affecting both ends in the same way.

For example, if the valve is a "direct" valve (taking steam on the outside and and no rocker), shortening the valve stem will increase the work done in the head end, but decrease the work done in the crank end, while decreasing the angular advance will delay cut-off and all events for the head end and will also delay all events for the crank end.

The usual procedure is first to adjust valve stem lengths to give approximate regulation of events; then to get the final adjustment by varying the eccentric. For case (a) a common procedure is to work for the designed lead. Each cylinder is set separately and the valve adjusted so as to get as nearly as possible the designed lead on the top center; then the engine is rolled over onto the other center and the lead measured. If not nearly that on the top center, the valve is raised or lowered one-half the difference. The same treatment is given to each cylinder successively and the accuracy of the setting for the entire engine depends on the accuracy of the data given the shop by the designer and the accuracy of the shop in keying the eccentrics.

Some shops set by the designed steam lap instead of the lead, as the quantity measured is greater and the error of measuring from the rough edge of the port is less. On piston valves the measure of the setting is observed through the peek holes provided for that purpose and on flat valves the valve chest cover is removed.

Case (b) is more involved and the procedure to follow depends largely upon the information available. In general, however, it is well first to adjust throughout for equal leads by the valve stems alone; then adjust eccentrics to even up approximately the events of both ends. If the eccentric is changed through a large angle, it is desirable again to adjust on lengths of valve stems for equal lead, and then follow up by a further adjustment of the eccentric. The engine should then be put under steam, indicator diagrams taken and the equalization of work per cylinder made from the information which they in this way furnish.

The following table will be helpful in noting the effect of various changes in valve setting for a three-cylinder, triple-expansion engine:

GENERAL EFFECT OF CHANGES IN VALVE SETTING
(Valve Direct Connected taking Steam on Outside)

Member Changed	Change	Admission	Cut-off	Release	Compr'ss	Max. Port opening, Steam.
Eccentric	Ang. Ad. Inc.	Earlier	Earlier	Earlier	Earlier	No effect
"	" " Dec.	Later	Later	Later	Later	" "
Valve Rod	Length. H.E.	Later	Earlier	Earlier	Later	Decrease
" "	C.E.	Earlier	Later	Later	Earlier	Increase
	Short. H.E.	Earlier	Later	Later	Earlier	Increase
	C.E.	Later	Earlier	Earlier	Later	Decrease
Steam lap	Lengthen	Later	Earlier			Decrease
	Shorten	Earlier	Later			Increase
Ex. Lap	Lengthen			Later	Earlier	Decrease
	Shorten			Earlier	Later	Increase

EFFECT OF CHANGING CUT-OFF
Three-cylinder, Triple Expansion Engine.

Member changed	Effect on Work Done in		
	High	Int.	Low
Lengthened in H. P.	More	More	About same
Shortened in H. P.	Less	Less	" "
Lengthened in I. P.	More	Less	No change
Shortened in I. P.	Less	More	" "
Lengthened in L. P.	Same	More	Less
Shortened in L. P.	"	Less	More

BOOK REVIEW

PRACTICAL SHIPBUILDING. Third edition. By A. Campbell Holms. Volume I (text); size, 6 by 9¾ inches; pages, 637. Volume II (diagrams and illustrations); size, 15½ by 12½ inches. Plates, 115. New York and London, 1916: Longmans, Green & Company. Price, $17.50.

The first edition of this standard work on shipbuilding was published in 1904, and a second edition, thoroughly revised, was published in 1908. Since the publication of the second edition further changes and developments have occurred in shipbuilding and departures from current practice, formerly exceptional or tentative, have now become general, and in various ways the structural design of vessels has been modified, principally with a view to securing increase of efficiency by reduction in weight and cost of construction. For this reason a third edition of the book has just been published.

In the third edition the revision has been extensive and thorough. Large portions have been entirely rewritten and the whole has been brought up to date by numerous additions, alterations and amendments. Three new chapters have been added on longitudinal framing, damage repairs and lifeboats and davits. A large amount of new matter has also been added in connection with oil vessels, oil fuel, fire extinguishing, freeboard regulations and bulkhead subdivision. Eighteen new plates have been added, several have been redrawn or suppressed in favor of others more instructive, and many have been amended so as to bring them up to date. The index has been carefully revised and amplified. As in previous editions the rules of Lloyd's Register are more particularly referred to, due probably to the fact that the author is a surveyor of Lloyd's Register of Shipping, but more space has been devoted, nevertheless, to the rules and methods advocated by other classification societies, the numerous references to which will be found both instructive and interesting.

The book, as a whole, represents the most complete work in existence on the subject of practical shipbuilding. The illustrations, reproduced to a large scale, are authentic and the whole work is a reliable guide to modern practice in steel ship construction.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Steel merchant vessels building, or under contract to be built in private American shipyards on January 1, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 403, of 1,495,601 gross tons, the largest tonnage in the history of American shipbuilding.

During December, 1916, American yards completed nine steel merchant vessels of 24,363 gross tons and entered into new contracts for twenty-nine vessels of 105,120 gross tons.

Barring unforeseen delays American shipbuilders expect to launch during the current calendar year 357 vessels of 1,250,722 gross tons.

Shipbuilding Contracts

Johnsen & Kildal, Inc., ship brokers, 26 Cortlandt street, New York, are in the market to contract for the building of two vessels of 8,800 tons each of the *Niels Nielson* type; four vessels of the improved *Frederickstad* type, and about six auxiliary motor schooners. This firm is also in a position to place any kind of vessel for ocean traffic for the account of several Norwegian buyers who desire to enlarge their present fleet of merchant vessels.

The Winslow Marine Railway & Shipbuilding Company, Winslow, Wash., has under construction a two-masted wooden steam schooner of approximately 1,250,000 gross tons for the Coastwise Steamship & Barge Company, Seattle, Wash. The propelling machinery will consist of a triple expansion engine of approximately 900 indicated horsepower, supplied with steam by two Heine watertube boilers, manufactured by the Union Iron Works Company, San Francisco, Cal. The engines are being built by the Seattle Construction & Dry Dock Company, Seattle, Wash.

The Washington Overseas Shipbuilding & Construction Company, Seattle, Wash., has received a contract from J. W. Isherwood, New York, for four auxiliary five-masted wooden schooners to cost approximately $230,000 etch.

The Superior Shipbuilding Company, Superior, Wis., has received an order from Norwegian parties to build four ocean-going freight ships. Each ship will be 261 feet long.

The Wallace Shipyards, Vancouver, B. C., have the following vessels under construction: One 4,500-ton steel freight ship for Japanese owners; one 4,500-ton steel freight ship for Norwegian owners; four 8,800-ton freight steamships for Norwegian owners; six 2,500-ton auxiliary schooners for The Canadian West Coast Navigation Company, Vancouver, B. C.

Phillip H. Doyen, South Portland, Me., states that he has contracts to build about one million dollars' worth of ships for Greek owners.

The Western Dry Dock & Shipbuilding Company, Fort William, Ont., has closed a contract for the construction of six ocean-going steamers and two freight ships for service in the Great Lakes. It is announced that the capacity of the company's plant is to be doubled.

The Pacific American Fisheries, Bellingham, Wash., is planning the construction of two more ocean-going ships.

The Electric Boat Company, Bayonne, N. J., has received an order to build some more 80-foot high-speed power boats for the British Government.

The Greenport Basin & Construction Company, Greenport, L. I., will build sixteen more high-speed power boats for the Russian Government.

The American Bridge Company, Pittsburg, Pa., has received a contract from the United States Steel Corporation, New York, to build seventy steel barges.

The C. Hildebrandt Dry Dock Company, South Rondout, N. Y., will build four large wooden barges for the Darrow-Mann Company, Boston, Mass.

The McLain Contracting Company, Baltimore, Md., will build a 95-foot wooden power lighter for the Costa Rica lumber trade. The lighter was designed by Bowes & Mower, Philadelphia, Pa.

No bids of a satisfactory nature were received by the Navy Department, Washington, D. C., for the construction of two colliers of 12,000 tons capacity. It is probable that specifications will have to be re-advertised.

Contracts are pending for about twenty-five steamers for 1918 delivery, and it is probable that orders will be placed for all of them during the first quarter of 1917, if shipyards can see their way clear to cover steel requirements.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Vacuum Oil Company, New York, to build two large tank steamships. The Harlan & Hollingsworth Corporation has also received a contract from the Vacuum Oil Company to build a general cargo steamer.

The Union Iron Works Company, San Francisco, Cal., has a contract to build a large oil tank steamer for the Vacuum Oil Company.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, to build two more 10,000-ton freight steamships. This makes a total of five steamers which the Fore River Shipbuilding Corporation is now building for the Luckenbach Steamship Company.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Spanish-American Iron Company, Philadelphia, Pa., to build two freight steamships.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Government of the Argentine Republic to build a fuel steamship, 330 feet long, to cost about $600,000.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Pittsburgh Steamship Company, Cleveland, to build another 600-foot ore boat, making three of that size ordered for 1917 delivery.

It is reported that the American Shipbuilding Company has received a contract from Carl D. Bradley, president of the Limestone Transportation Company, Rogers City, Mich., for a $500,000 ship for 1917 delivery.

The United Engineering Works, San Francisco, Cal., has received a contract from C. Henry Smith, Inc., San Francisco, Cal., to build a 340-foot steel freight steamship.

The Navy Department, Washington, D. C., has awarded a contract to the New York Navy Yard to build battleship No. 43 at a cost of $7,690,925.

The Navy Department has awarded the Mare Island (Cal.) Navy Yard the contract to build battleship No. 44 at a cost of $7,413,156.

Johnson Bros. & Blanchard, Seattle, Wash., have a contract from the Westwood Navigation Company, Seattle, to build a 150-foot wooden vessel to be equipped with twin-screw gas engines.

It is reported that the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received contracts from Norway to build four more oil engined ships.

It is reported that The Texas Company, New York, has purchased the shipbuilding plant of Arthur Sewell at Bath, Me., and will shortly begin the construction of a fleet of 20 steel barges for transporting oil in bulk.

It is reported that the Government of Canada is planning to authorize an issue of bonds to provide for the building of 30 four-masted ships to be turned over to lumber manufacturers of British Columbia. It is said that enough bonds have already been subscribed to make it possible to lay the keels of six of these ships within a few months.

It is reported that the Atlantic, Gulf & West Indies Steamship Lines, New York, have decided to build several large passenger ships.

The Electric Boat Company, New York, has signed a contract with the Navy Department, Washington, D. C., to build twenty-one submarines, of which twenty will be of the coast defense type and one of the fleet type. The contract involves about $17,000,000.

Babare Bros., Tacoma, Wash., have received a contract to build thirty-five fishing boats and cannery tenders, at an aggregate cost of about $230,000.

George F. Thorndyke, a ship broker of Seattle, Wash., has asked for tenders for six wooden four-masted schooners of the Pacific Coast type, each to be of 1,000 tons net register.

The Richard T. Green Company, Chelsea, Mass., has received a contract to build a four-masted wooden barkentine for the Federal Transportation Company.

(Photograph by Press Illustrated Service, Inc., N. Y.)

U. S. Cruiser *Milwaukee* Becomes Total Loss When Driven Ashore on Shoals off Eureka, Cal., on January 13

Shipbuilding Notes

The Standard Shipbuilding Company, New York, has let a contract for the steel to be used in the enlargement of its plant in Shooter's Island.

It is stated that the People's Shipbuilding & Construction Company has been organized, and that a yard for building wooden vessels will be erected at Gig Harbor, Wash.

F. O. Northrup, Portland, Ore., states that another wooden shipbuilding plant will be erected in South Portland, Ore.

The Erickson Shipbuilding Company has been organized in Seattle, Wash., C. J. Erickson is president and E. L. Grondahl is secretary.

It is reported that the United States Steamship Company, New York, has selected Hamilton & Chambers, New York, as engineers to design its proposed shipbuilding plant at Groton, Conn.

The Providence Engineering Works, Providence, R. I., has been incorporated, with a capital stock of $500,000, by William E. Hussey, William B. Dukeshire and Edgar H. Mead, all of Brooklyn, N. Y. The company proposes to build a new line of marine engines, and the incorporation papers permit it to carry on a general shipbuilding business.

The Vancouver Dry Docks, Ltd., Vancouver, B. C., have completed plans for the construction of a floating drydock of 18,000 tons capacity. The company announces that it will build a shipbuilding and repair plant as soon as the dock is completed. Charles Meek, of Vancouver, is president.

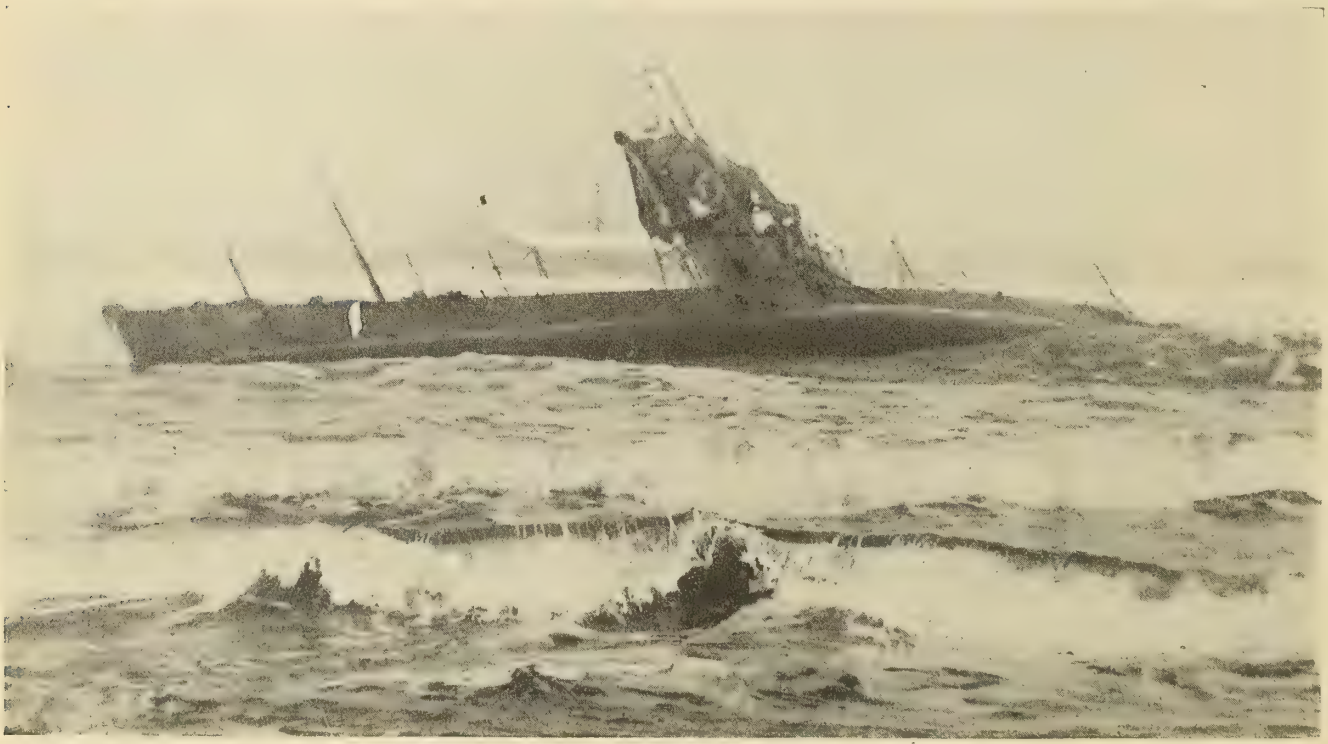
Construction at the Philadelphia Navy Yard of a slip for building one of the four battle cruisers authorized by Congress has been determined upon by Secretary of the Navy Daniels.

The Keyport Dry Dock Company, Keyport, N. J., has taken over the entire plant of the Keyport Marine Railways Company, and is prepared to build and repair scows, barges, lighters and similar craft.

The Albina Engine & Machine Works, Portland, Ore., having received contracts to build four 3,800-ton steel steamers, announces that the plans of its shipbuilding plant have been changed so as to include five ways instead of two as previously announced.

The Lake Torpedo Boat Company, Bridgeport, Conn., will build another large addition to its machine shop and also additions to its docks and warehouses.

The Los Angeles Shipbuilding Company, Los Angeles, Cal., is planning to erect a shipbuilding plant to cost $500,000. E. G.



(Copyright, Underwood & Underwood, N. Y.)

United States Submarine *H3*, Stranded on Shoal near Eureka, Cal. The Vessel Went Ashore in a Fog

(Copyright, Underwood & Underwood, N. Y.)

Storm Drives S. S. *Bear* on the Rocks near Eureka, Cal.

Eckstrom, Los Angeles, is president of the new company.

It is reported that the plant of the Washington Overseas Shipbuilding & Construction Company, Aberdeen, Wash., is near completion. The company is stated to have contracts to build seven auxiliary lumber schooners.

It is announced that the Todd Shipyards Corporation, New York, which controls the Seattle Construction & Dry Dock Company, of Seattle, and other properties, will erect a shipbuilding plant in Tacoma, Wash.

It is reported that Seattle, Wash., shipping men, headed by R. M. Calkin, traffic manager of the Chicago, Milwaukee & St. Paul Railway, are organizing a company to build and operate three steamships to ply between Seattle, Honolulu, Australia and New Zealand.

The Anderson Shipbuilding Company, Seattle, Wash., has been incorporated, with a capital stock of $1,000,000, by J. L. Anderson, E. H. Flick, A. J. Weiffenbach and James Campbell.

The Northwestern Shipbuilding Company has been incorporated, with its main office in the California building, Tacoma, Wash. The capital stock is $100,000. Mr. C. A. Papst, president of the company, writes Marine Engineering that he is preparing to move the yard to Tacoma, where the company expects to build several large vessels.

The Northwest Marine Construction Company has been organized at Port Townsend, Wash., by A. McFarland, San Francisco, and F. J. Carver and B. M. Pinney, of Seattle.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., has been incorporated by Ernest Kreher, Peter O. Knight and others, and has acquired the plant of the Tampa Machine & Foundry Company. It is proposed to enlarge the plant and to build steel ships.

It is reported that the Canadian Government is planning an expenditure of $30,000,000 on a shipbuilding plant, terminals and other improvements to the port of Halifax, N. S.

Marine Terminal Improvements

The Pennsylvania Railroad Company, Broad Street Station, Philadelphia, Pa., has asked for bids for improving and enlarging Pier 46, Philadelphia.

The Donner Steel Company, recently incorporated in New York State, with $5,000,000 capital, has taken over the plant of the New York State Steel Company, Buffalo, and will make extensive improvements, including building ore docks along the Buffalo River.

The Norfolk Storage Company, Inc., recently organized at Norfolk, Va., has purchased a site of 19 acres near Norfolk, and will build docks and sheds.

Has Reliability of Motorships Yet Arrived?

The 7,200-ton motorship *Sebastian* arrived in New York on her fourth visit on December 27, having had an exceptionally stormy passage from Rouen, France. One of her two 1,100-indicated horsepower Werkspoor Diesel engines made a nonstop run, and the other was stopped for one hour while a very minor adjustment was being made.

Chief Engineer Cole of the *Sebastian* states that the longest stop of either engine since this vessel was placed in service on June 21, 1916, has been six hours, which was due to a sea water connection breaking and the water getting into the lubricating oil. The engine had to be stopped while the watery oil was drained out and the leak repaired.

Chief Engineer Cole further states that the engines are perfectly reliable, and that he would not hesitate to go to sea with only one engine. Her two main oil engines together averaged a fuel consumption of 5.6 tons of residual oil fuel

per 24-hour day, while the donkey boilers used 1.9 tons of oil per day.

Launching of S. S. Julia Luckenbach

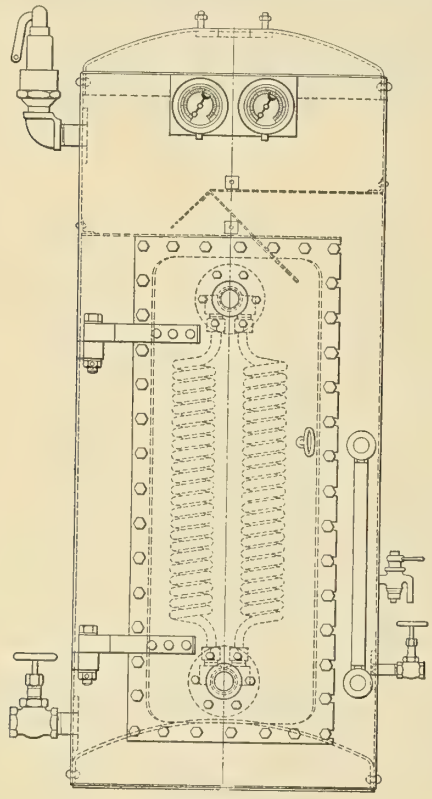
The *Julia Luckenbach,* launched December 23, 1916, sponsor Miss Andrea Tenurck, is the second of a fleet of five large oil-burning freighters now under construction by the Fore River Shipbuilding Corporation for the Luckenbach Line of New York to engage in the general carrying trade. The *Edward Luckenbach,* the first vessel built under the contract, left the Fore River yards three weeks ago, having fulfilled every requirement of her trials.

The *Julia Luckenbach,* like the other vessels of the fleet, was constructed to special designs for the Luckenbach Steamship Company for its coast to coast and oversea trade. Her length is 456 feet over all, and she has a deadweight carrying capacity of 10,000 tons. In the adoption of the modified cruiser stern, the novel arrangement of bridge and deckhouse bulwarks, one large smokestack amidships, she is a handsome vessel of distinctive appearance. Her wide spaced frames are specially designed for the economical carriage and rapid handling of freight.

The vessel is driven by a single Curtis turbine, with high and low-speed reduction gears, designed to deliver 4,000 horsepower at 90 revolutions, the turbine being so arranged that the ahead and reverse turbines are carried on one shaft and contained in one case. Steam is furnished by three boilers of the Scotch marine type, the fuel oil being carried in the double-bottom compartments and in the forward and afterpeak tanks.

Paracoil Evaporator

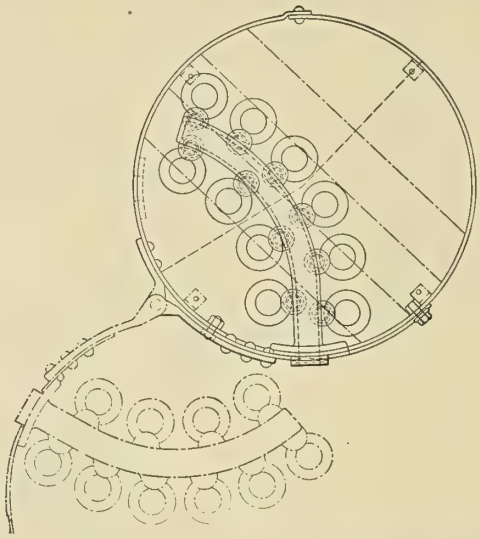
The R & D Paracoil Evaporator, illustrated herewith, which is manufactured by Row & Davis, Engineers, Inc., 90 West street, New York, provides a supply of pure distilled water for boiler feeding, drinking, bottling, manufacturing processes, etc. Steam of any initial pressure from 200 pounds



R & D Evaporator

gage down to atmospheric may be utilized for heating the raw water, so that the evaporator may be operated as a single unit or with multiple effect. Where exhaust steam is available for the heating, the distilled water can be produced without other expense than the upkeep on the evaporator, and an adequate water supply for drinking and other limited use is secured practically for nothing.

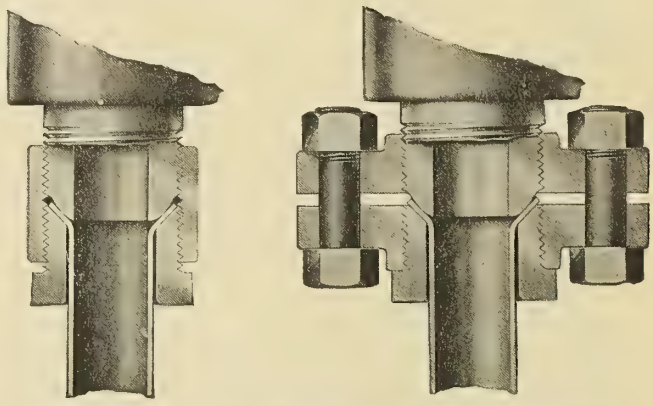
The raw water is fed constantly into the shell of a single-effect, or of the first unit of a multiple effect, plant at a rate corresponding to that of ebullition, the water level carried at any time being always shown by a gage glass. As this water evaporates the impurities are left behind, and when accumulated are removed through a blow-out valve. The distillate is



The New Arrangement of Manifolds Which in Connection with the Hinged Door Makes the R & D Evaporator Easy to Clean

passed to a surface condenser in a single effect, or into the heating coils of the succeeding unit of a multiple-effect, plant.

The raw water is heated to ebullition by steam of higher pressure and temperature circulating and condensing in a group of helical coils arranged for parallel flow between inlet and outlet manifolds and placed respectively in the vapor and water space within the shell. The condensation from the heating coils is trapped out, and if filtered to remove oil, grease or other particles that may float in with the steam, can be reused as boiler feed water, thereby conserving practically all of the contained heat. This heating steam and its condensation do not come into contact with the raw water and vapor, and therefore cannot contaminate the output of the evaporator unit. The vapor in a single-effect plant passes direct to a condenser, from which it is delivered as distilled water ready for use. With the multiple effect principle the vapor from the first unit is passed into the heating coils of the second unit to boil more raw water at lower temperature and under lower pressure in the shell of the second unit and so on throughout the series. The condensation from the heating coils of all units except the first in the multiple-effect plant is trapped individually from each unit into a common drain, which de-



Types of Coil Connections Used in the R & D Evaporator

livers into the same hot well or receiver as does the surface condenser which receives the vapor from the last unit. If the distillate is to be used solely for boiler feeding the returns from the heating coils in the first unit also, if filtered, can be safely passed along into the well or receiver and greater economy thereby effected. As further practical economy the sensible heat in the distillate of the earlier stages can be utilized to heat the steam going into the later stages, which is done by means of interchangers.

Novel construction features of the R & D evaporator are indicated clearly by the illustrations. The side of the shell is provided with an extra large door, curved to the same radius as the shell metal, hinged, gasketed and held by studs and nuts.

The top and bottom manifolds for steam inlet and condensation drain, respectively, are similar, are of cast iron or bronze, are fastened to the inspection door by flanges, and are of a distinctly new arc type, that in connection with the hinging of the door enables the entire heating section to be swung outside for convenient inspection, cleaning or repair. The form of manifolds permits of an ample area of heating coil surface to be placed toward one side of the shell, which gives a much greater space for the vapor than that occupied by the large body of water from which it is generated. The large free space also affords complete and direct circulation without the vapor currents coming into conflict. A simple but effective form of baffle in the top permits priming.

This construction also has the manifold entirely free from the shell, which minimizes expansion strains and avoids expansion gaskets and leakage.

The coils are of seamless drawn copper, and are of a form that puts practically no strain on the joints. The helical form also permits a very great amount of heating surface to be compacted into small space, and provides for a natural contraction and expansion when the coils are suddenly flooded with cold water for washing off scale. This, to a great extent, eliminates hand washing.

The joints between coils and manifolds are made by slightly flaring the tube end and locking it between a tapered nipple on the manifold and a corresponding brass bushing. The latter is brought up tight by screwing into a brass lock nut that also threads onto the nipple. As an alternative construction for those who prefer a flanged to a locked joint, the lock nut may be replaced by a pair of two-bolt flanges, as shown. Both arrangements permit the blanking out of a coil temporarily by the use of two standard pipe caps or by putting blind washers in the joint.

These evaporators comply in every respect with regulations of the Board of Supervising Inspectors, Steamboat Inspection Service. The shell is tested to 50 pounds and the coils and manifolds to 500 pounds hydrostatic pressure. Sizes are made with capacities up to 75 tons per 24 hours.

Fourth National Foreign Trade Convention

All Americans engaged in or desirous of entering overseas commerce had an unusual opportunity to discuss the development of the American merchant marine at the Fourth National Foreign Trade Convention, held at the William Penn Hotel, Pittsburg, Pa., on January 25 to 27. In addition to the discussion of the conditions affecting the American overseas shipping the programme included a number of the papers by national authorities on such subjects as "World Trade After the War," "America's Position in World Finance," "Co-operation in Foreign Trade," "Commercial Education" and "Problems of Manufacturers and Merchants."

One of the most interesting and instructive papers presented is that on "The Present Position and Prospects of American Shipbuilding," by J. W. Powell, president, Fore River Shipbuilding Corporation, Quincy, Mass., who calls attention to the importance of the opportunities waiting to the hand of the newly-appointed Shipping Board for re-establishing the American merchant marine in foreign commerce.

Battleship Mississippi Launched at Newport News

The 32-ton battleship *Mississippi* was launched at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., on January 25. The vessel is 600 feet long, 97 feet 4½ inches beam, and 30 feet mean draft. With Curtis turbines of 32,000 horsepower, fitted with reduction gears for cruising, a speed of 21 knots will be developed. The main armament consists of twelve 14-inch guns, arranged in four turrets of three guns each.

Recent Launchings

Percy & Small, Bath, Me., launched on January 13 the wooden auxiliary schooner *Samuel C. Mengel* of 809 gross tons, which is intended for carrying mahogany from the west coast of Africa to Pensacola for Mengel Bros., of Louisville, Ky.

The New York Shipbuilding Corporation, Camden, N. J., launched on January 18 the steam collier *Tidewater* of about 8,500 tons deadweight, for the Darrow-Mann Company, Boston, Mass.

The Newport News Shipbuilding & Dry Docks Company, Newport News, Va., Launched on January 12 the steamship *Felix Taussig,* building for the Crowell & Thurlow Steamship Company, Boston, Mass.

Improvements at Puget Sound Shipyards

The Winslow Marine Railway & Shipbuilding Company, Winslow, Wash., has expended approximately $50,000 in the past sixty days in rearranging car tracks and improving and installing new yard equipment. The company has just completed a new ship shed designed to accommodate vessels 300 feet in length. The shed is equipped with a modern overhead trolley system for handling material, and its erection is part of a plan which calls for four such sheds to be erected at the yard as the demands of new contracts warrant.

The Washington Overseas Shipbuilding & Construction Company, Seattle, Wash., has taken a ten-year lease of the Sumner Iron Works plants at Everett, Wash., which was partially destroyed by fire some time ago. This plant has a water frontage of 1,280 feet, including a wharf, and the equipment also includes a 300-foot floating dry dock.

Personal

HENRY S. GROVE, president of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., handed his resignation to the directors of the company at their January meeting. At the same time Albert Strauss and Francis L. Hine resigned as directors of the company. All three of these men have been closely associated in the management of this extensive shipbuilding property in the past thirteen years.

R. H. BLAKE, formerly in charge of the Australian freight department of Funch, Edye & Company, agents for the Commonwealth & Dominion Line, Ltd., of London, has been appointed manager of the freight business of the Cunard Steamship Company.

REAR ADMIRAL D. W. TAYLOR, chief constructor of the United States Navy, has been promoted to the rank of rear admiral, irrespective of the present duties as head of the Bureau of Construction and Repair.

REAR ADMIRAL ROBERT S. GRIFFIN, engineer-in-chief of the United States Navy, has been promoted to the rank of rear admiral, irrespective of his duties as chief of the Bureau of Steam Engineering.

M. A. HERNANDEZ, 26 Cortlandt street, New York, has assumed charge of the branch office of Johnsen & Kildal, A/S, Christiania, Norway. J. Walter Johnsen is president, Berger Kildal vice-president, and Mr. Hernandez secretary-treasurer and general manager. Mr. Johnsen and Mr. Kildal are at present in Norway.

JOSEPH B. WEAVER, superintendent of hull construction of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has resigned to become vice-president and general manager of the Harlan & Hollingsworth Corporation, Wilmington, Del.

H. PERRY PHELPS has been named plant engineer by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., a position recently created. He will have supervision of the plant machinery, including the installation of a large amount of new machinery for which the company recently made an appropriation.

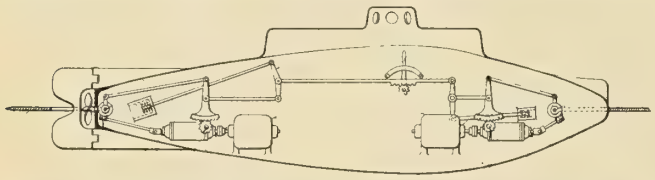
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,187,738. PRESSURE-CONTROLLED GOVERNING APPARATUS. REYNOLD JANNEY, OF NEW YORK, N. Y., ASSIGNOR TO THE WATERBURY TOOL COMPANY, OF NEW BRITAIN, CONN., A CORPORATION OF CONNECTICUT.

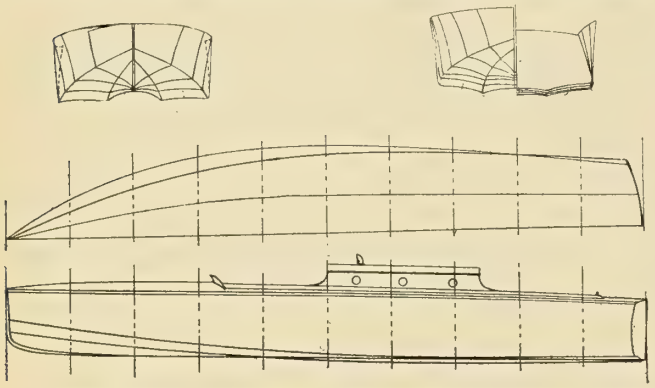
Claim 1.—An apparatus comprising a hydraulic variable speed gear including a controlling device, a governing member operatively connected with the hydraulic variable speed gear, means for operating said



controlling device at will to cause the hydraulic variable speed gear to move the governing member from its neutral position, and pressure controlled means acting upon said controlling device for returning said governing member to its neutral position. Thirteen claims.

1,189,227. BOAT. LEWIS R. BAKER, OF BALTIMORE, MD.

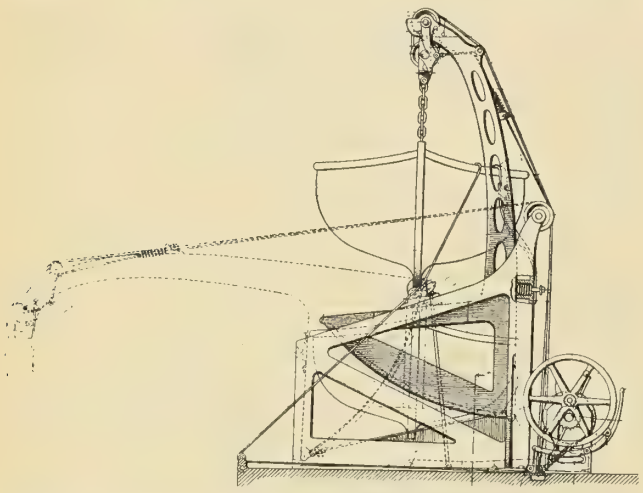
Claim 1.—A hydroplane hull with the planing runners joined rigidly



by a concave shaped channel to a point from approximately midship rearward. Five claims.

1,190,046. AUTOMATIC DAVIT. RICHARD TJADER, OF NEW YORK, N. Y.

Claim 1.—In an automatic davit, the combination of a pair of vertically arranged rigid supporting brackets each having near its base a track member and having sockets formed at the upper and lower ends thereof, a pair of davit arms supported upon said brackets and each including a rocker member co-operating with the track member of the



supporting bracket of such arm, said co-operating rocker and track members having relatively curved and straight coacting surfaces, each rocker member furthermore having at its ends a pair of downwardly projecting toes adapted to co-operate at the ends of the rocking movements with the aforesaid sockets, and a flexible flat metallic strap extending between said engaging surfaces and connected at its opposite ends to the rocker and track members respectively, said flat strap receiving directly the impact and rolling friction between the rocker and the tread member. Eleven claims.

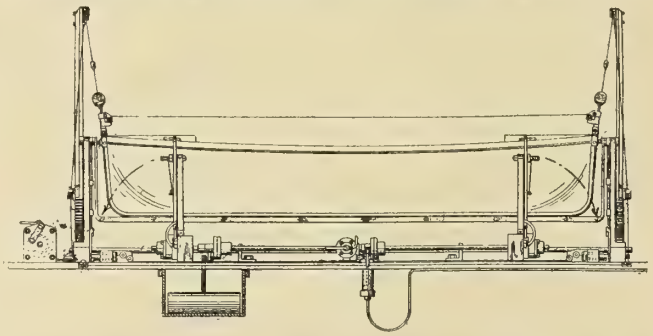
1,189,686. FIRE INDICATING AND EXTINGUISHING SYSTEM. FRANK C. HAASSLER, OF BROOKLYN, N. Y.

Claim 1.—The herein described combined fire indicating and fire extinguishing system for ships, comprising jointly standpipes adapted to extend from the upper deck of said ship down and into the hold and intermediate decks thereof, each of said standpipes provided with an opening and closing valve at its upper portion, each of said standpipes provided at or near its upper end with an announcing or smoke escaping outlet, each of the said standpipes provided at its lower end with perforated branch pipes adapted to convey smoke from the compartment of the ship to the said standpipes or to distribute fire extinguishing mediums from the said standpipes into the compartments of said ship, fire extinguishing supply pipes in pairs adapted to lie in close proximity to said standpipes, means for connecting said supply pipes to the said standpipes, each consisting of a permanent Y coupling, whereby the said standpipes can be supplied with one or both mediums for extinguishing fires at the same time, said Y couplings provided with opening and closing valves and cocks, and means for supplying the said supply pipes with the extinguishing mediums. Four claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

101,520/16. "IMPROVEMENTS IN OR RELATING TO DAVITS." G. J. PHILLIPS, COMMERCIAL BROKER, AND L. A. KELLER, ELECTRICAL ENGINEER, BOTH OF 17A PITT STREET, SYDNEY, AUSTRALIA.

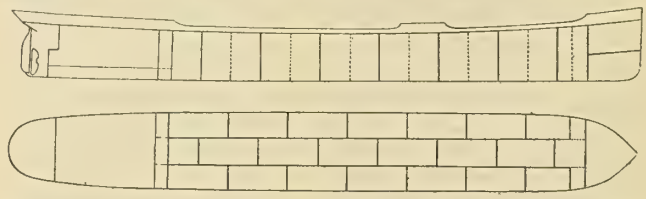
This invention has reference to davit arrangements and more especially those intended for use with means for holding and releasing boats, rafts, and the like, on board ships. In the specification of former letters patent No. 25,477, of 1912, and the specifications of applications for letters patent No. 11,032, of 1915, and No. 7131, of 1916, holding and releasing means are described in connection with which the present improvements are especially applicable. According to the present invention the davits of the kind that are pivoted near their lower ends and tend to swing outward automatically when they take the weight of the boat are formed, below their pivots with toothed quadrants geared



through toothed wheels with a common longitudinal shaft so that the davits swing in and out together. If the vessel has a considerable list it may happen that the davits will be so inclined inboard that they will not swing outwards when the weight of the boat is taken, and our invention comprises improved means for overcoming this difficulty, such means enabling the davits to be positively swung outboard until they pass beyond the vertical by means of hand lever with pawl provided in connection with a gear wheel on the longitudinal shaft whereby the shaft can be rotated sufficiently for the purpose, a detent preventing backward rotation of the shaft between the operative strokes of the lever; the detent may be so arranged as to be disengaged by the lever towards the end of its idle stroke so that the detent will not then prevent the davits being swung inboard again. If desired, the levers may be adapted to actuate the shaft so as to swing the davits inboard, for instance, the pawl may be reversible so as to work in either direction.

16,016/15. "IMPROVEMENTS RELATING TO SHIPS FOR CARRYING LIQUID CARGOES IN BULK." H. LAING, SHIPBUILDER, OF DEPTFORD YARD, AND E. W. ASHBY, NAVAL ARCHITECT, OF 4, DUNBAR STREET, BOTH IN SUNDERLAND, IN THE COUNTY OF DURHAM.

This invention relates to ships for carrying liquid cargoes in bulk, such as oil or molasses, and has for its object to provide an improved construction thereof, whereby increased longitudinal strength and other advantages are obtained. In a liquid cargo carrying vessel of the type known as a "tanker" one or more of the transverse bulkheads is or are



arranged so that, when a single longitudinal straight-line bulkhead if provided and the cargo space thus divided into two longitudinal compartments, the portions of the transverse bulkheads crossing the compartments on each side of said longitudinal bulkheads are not in line the one with the other, but are stepped a convenient distance away, and where two longitudinal straight-line bulkheads are provided and the cargo space divided into three longitudinal compartments, one or more of the bulkheads crossing the center longitudinal compartment are not in line with the bulkheads crossing the side longitudinal compartments, but are stepped a convenient distance away.

17,817/15. "IMPROVED MEANS FOR FASTENING SHIPS' ROPES TO MOORING BUOYS, MOORING RINGS, AND THE LIKE." W. J. JOHNSON, OF 43 CORBRIDGE STREET, SOUTH SHIELDS, IN THE COUNTY OF DURHAM, RIGGER AND STEVEDORE.

The end of the wire rope is provided with the usual large loop or eye formed by bending the rope back on itself and joining the end to the rope by splicing or other method. A comparatively long metallic sleeve or ferrule is threaded on the rope and over the splicing, the hole through the sleeve being tapered and shaped to fit the splicing. A lateral lug or elbow shaped projection is formed on one side of the sleeve comprising means whereby a separate shackle of suitable strength or the loop itself can be easily attached to said lug or projection.

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The Nation's First Line of Defense

WITH the present dangers confronting the safe conduct of American over-seas commerce, citizens of the United States can no longer fail to realize the responsibilities that rest upon the United States Navy. Nor can they fail to appreciate the fact that the strength and efficiency of the navy are dependent upon the support of the American merchant marine, its officers and men, and the shipbuilding resources of the country. In this time of danger let no partisan or selfish motives weaken the nation's first line of defense.

Emergency Measures

FOLLOWING closely President Wilson's proclamation of February 5 prohibiting shipowners of the United States from transferring to foreign registry without the consent of the Shipping Board any vessels registered or enrolled and licensed under the laws of the United States, an emergency shipping bill is now before Congress which practically provides for the mobilization of merchant shipping in the interests of national defense. This measure is similar to the legislation previously enacted by most of the nations now at war. It is designed not only to prevent the transfer of American merchant tonnage to foreign ownership, but also to prevent the transfer of shipbuilding contracts from citizens of the United States to aliens and to give the United States Government an opportunity to acquire through the Shipping Board vessels now building in American shipyards for foreign account. The enactment of this measure will give the government full power to mobilize the merchant shipping of the United States, and if such a step becomes necessary, it can be accomplished without delay and on an equitable basis for the interests involved.

Military Value of the Merchant Marine

ACCORDING to Admiral Sir John R. Jellicoe, First Sea Lord of the British Admiralty, and formerly Commander-in-chief of the Grand Fleet of Great Britain, the approximate number of vessels of all classes which comprise the British Navy of to-day is nearly 4,000. This includes battleships, battle cruisers, light cruisers, destroyers, submarine boats, mine sweepers, patrols and many other miscellaneous craft, all of which are necessary for the effective conduct of a war of to-day. The task of keeping this enormous mass of ships working in all parts of the world, of supplying them with fuel, munitions, etc., obviously involves the undivided support of the country's merchant marine. To quote Admiral Jellicoe's words:

"Without our mercantile marine the navy, and, indeed, the nation, could not exist. Upon it we have been dependent for the movement of our troops over seas, over 7,000,000 men having been transported along with the guns, munitions and stores required by the army. We have had to draw upon the personnel of the mercantile marine not only for the manning of transport ships, but also very largely for the manning of the whole of our patrol and mine-sweeping craft. Indeed, it is impossible to measure fully the debt which the country owes to our mercantile marine."

Can these words be meaningless to those who for over half a century have persistently blocked the upbuilding of the American merchant marine?

Critics of the Navy Department

MOST of the criticism recently aroused against the Navy Department's battle cruiser designs apparently originated either from persons financially interested in some form of propelling machinery which they hoped to have incorporated in these designs or from disinterested but uninformed persons with a smattering of engineering training whose superficial knowledge of warship design and lack of understanding of the military value of the various factors governing the design of these particular vessels make their criticisms practically valueless. Needless to say, the design of every warship represents a compromise, and without a complete understanding of the various factors governing the design, both from a military and from an engineering standpoint, criticisms are of little value. As a matter of fact, the new battle cruisers represent a step far in advance of anything which has so far been attempted in warship design in any country, and the features now subject to outside criticisms have received the unqualified approval of the general board of the navy only after the most careful and mature deliberation.

What American Classification Means to Shipbuilders and Ship Owners in the United States

THE recent activity in shipbuilding in the United States created an immediate demand from both shipbuilders and ship owners for a strong American classification society competent to meet adequately and promptly the needs of American shipbuilders, ship owners and marine underwriters. The previous lack of such a classification society made it necessary for practically all American ships to be classified by foreign societies. The standards of such societies, of course, were based primarily upon the type of construction prevailing in their respective countries and, in general, for sea-going service. A large part of American shipping, however, is comprised of vessels of a distinctly American type for coastwise, lake, river, sound or harbor service. The application of foreign classification standards to such vessels required frequent reference to the home offices of such classification societies in foreign countries for the approval of design and changes in construction. Such conditions meant frequent delays and seriously hampered the work

of American shipbuilders. It is evident that such conditions could be entirely avoided if a strong American classification society were available. With this object in view, the complete reorganization of the American Bureau of Shipping was placed in the hands of Mr. Stevenson Taylor, president of the Society of Naval Architects and Marine Engineers, and the anticipated results immediately began to be realized. Under Mr. Taylor's competent guidance the affairs of the Bureau have been thoroughly organized, the classification rules have been revised and brought up to date and American shipbuilders and shipowners can now secure what they have hitherto sadly lacked—the prompt and competent services of a thoroughly American classification society whose standards are equal or superior to any in the world.

Preliminary Report of Bulkhead and Load Line Committee

The committee of shipbuilders and shipowners, headed by Mr. Stevenson Taylor, president of the American Bureau of Shipping, recently appointed by Secretary of Commerce Redfield to investigate the question of bulkhead and loadline regulations for American ships, has drawn up a preliminary report which the Secretary of Commerce has laid before the United States Shipping Board. The report comprises two sections, one dealing with sea-going ships and the other with coastwise, lake, bay and sound vessels.

As far as the sea-going vessels are concerned, the committee recommends that the United States adopt a method for the determination of freeboard which will give in general the same loadline as that established by the present British practice. It is recommended that this method remain in force until such time as an international commission shall be called to establish an international loadline. As British tables at present in use, however, are recognized as being somewhat cumbersome, the committee points out that some revision should be made in the tables in order to conform to present-day American practice in shipbuilding. These recommendations readily commend themselves to all who are concerned with the loadline question, as this problem has been the subject of an exhaustive investigation by British authorities and there seems little need for a repetition of this arduous work, as it is generally conceded that the present loadlines as established by the British practice render the ordinary types of sea-going vessels safe and seaworthy.

The question of coastwise, lake, bay and sound vessels, however, cannot be settled so readily, as vessels engaged in such service are not only operating under different conditions, but are in most cases of a different type of construction when compared with ocean-going types. Consequently, any set of freeboard tables based upon ocean-going vessels would be inapplicable to such vessels. The loadline committee, therefore, recommends that the present committee be continued and conduct an investigation and draw up a set of rules and tables which will fully meet the requirements of all American coastwise, lake, bay and sound vessels. The preparation of such rules and tables obviously would involve a thorough and exhaustive examination of existing vessels in order to establish what may be called the American practice in loading and operating such vessels. As proper, just and safe loadlines can be established only after such an investigation has been made, and the results carefully analyzed by proper scientific methods, and as such an investigation will necessarily take some time and involve some expense, the committee very properly recommends that the United States Shipping Board appoint one or more of their members to sit with the committee in their deliberations and that a fund be established to take care of the necessary expense involved in such an investigation. In presenting this recommendation to the Shipping Board, the committee points out that if it is deemed improper for the Shipping Board to apply any of its funds for this purpose, the committee should be authorized to take such steps as are necessary to raise such funds.

The work proposed by the committee is of the utmost importance, and the necessary funds for conducting such an investigation should be promptly provided. Considerable work has already been accomplished by several members of the loadline committee, and this important investigation should not be left wholly to their generosity.

Filing Data on Shipbuilding and Shipping

BY ERNEST K. ROSCHER

Of the various data-filing systems which were published since Marine Engineering issued an appeal to its readers to contribute articles giving their experience in regard to this highly vital problem for a marine man the one which was published in the issue of July, 1916, seems to be the most practical. However, as the author himself in this case pointed out, his system of subdivision was worked up gradually and was not built up in a systematic manner. In the form presented, therefore, this system is not generally acceptable, although it undoubtedly is of great value to its originator.

In the system described below the main features of the previous system are adopted, but the systematical subdivision is new. This feature alone makes it possible for the system to cover the subjects exhaustively and still to make it more easily acceptable for universal use. It is also the aim of the author to find a system which will answer office requirements as well as private purposes.

The file container consists of the type of box cabinet, with large drawers and loose folders for filing, usually used for correspondence. A short description of the system and index is filed in the first box of the cabinet and a copy of this description and index is given to each person that either uses the file or is contributing to it. This description and index is substantially as follows:

Explanation of System

The system is intended for filing loose articles and clippings which contain data valuable for ship design, building, maintenance and operation.

The clerical work of filing shall be reduced to a minimum.

Articles shall be designated so as to leave as little doubt as possible regarding the information which they contain. Minute subdivision of subjects is desirable as long as it does not increase the possibility of doubt as to where to file an article or as to where to look for certain information.

Index

Leading subjects are systematically subdivided into a number of subjects of second order. A signum, consisting of letters of the alphabet, is assigned to each leading subject and each subject of the second order. The combination of two of these signs separated by a dash forms the designation of a folder in the file box. As, for instance:

	H-ST	Hull—On Stability and Trim.
or	H-W/F	Hull—Weights of Freight Steamer.
or	H-WM/Tg	Hull—Weights of Machinery of Tug-boat.
or	PM-RD/RG	Propelling Machinery—Reciprocating steam engine details, reversing gear.

A third signum, also consisting of letters of the alphabet, and always arranged in the third place in the filing number, is intended still further to designate the precise information contained in a certain clipping. As, for instance:

H-ST-Th Hull—Stability and Trim—Theory.
or H-ST-Li/Fr Hull—Stability and Trim—Notes on French literature.

Handling of System

Each person who contributes to the file is supplied with a copy of the index. After reading an article he determines under what subject of the first class and also of the second class and, if necessary, of the third class the article should be filed, and marks the signa above the title of the article. Magazines which pass successively through the hands of different persons interested in their contents should receive on their covers the signature of each person and the date on which they are examined in order to indicate that all information in the magazine valuable to the various readers is marked.

After having been passed around, the magazines go to the filing clerk, who cuts out the articles designated by the readers, puts a note at the bottom, indicating the magazine from which the article is taken and also the date of publication, and files them away. Small clippings are pasted on a larger piece of paper.

Folders in the file box are arranged alphabetically according to the leading groups of subjects. Folders on subjects of second order within the leading groups are again arranged alphabetically. Whenever it becomes necessary a special index may be filed within the particular folder.

Additions or minor changes of the index may become necessary at times, but should always be made with a view to avoiding confusion in the index.

Index of Leading Subjects

Number	Name	Signum
1	General description of ships	G
2	Hull	H
3	Propelling Machinery	PM
4	Auxiliary Machinery	AM
5	Deck Machinery	DM
6	Stationary Machinery	StM
7	Boilers and Boiler Plants	B
8	Tests	T
9	Practical Problems	PP
10	Accidents and Salvage Work	A&S
11	Materials and Material Treatment	M
12	Piers, Docks, Loading and Discharging	P
13	Shipyards and Shipyard Work	SY
14	Shipbuilding	Sb
15	Ship Lines	SL
16	Shipping	Sp
17	Industrial Notes and Market Reports	IM
18	Mathematics	Mat
19	Mechanics	Mec
	Navy (combined with any of the above)	/N

LEADING SUBJECTS DETAILED

(1) *General Description of Ships:** "G"

Passenger boats, seagoing....G-P
Passenger and freight boats, seagoing....G-PF
General freight boats, seagoing....G-F
Tank-ships, seagoing....G-Tk
Colliers, seagoing....G-CO
Ore-carriers, seagoing....G-Or
Lumber-carriers, seagoing....G-Lb
Barges, seagoing....G-B
Battleships....G/N-BS
Battle cruisers....G/N-BC
E T C.
(To be combined with any of the above.)
Paddle wheel....G-/PW
Stern wheel....G-/SW
Tunnel stern....G-/T
Auxiliary motor....G-/AM

* Note: Whenever possible, mark length of ship in feet, for instance: G = Tk 420 or G = MY 30. All general descriptions of ships in which the propelling machinery is the most interesting features, such as Diesel motors, producer gas plants, etc., filed under "PM."

(2) *Hull:* "H"

Weights and capacities, general, according to type of ship: H-W/P, H-W/PF, H-W/F
Hull....H-WH
Machinery....H-WM
Outfit....H-WO
Cargo....H-WCg
Dimensions and proportions.H-DP
Stability and trim....H-ST
Bulkheads....H-Bhd
General....H-G
Resistance and horsepower...H-R
Propellers....H-P
Strength—General....H-SG
Local....H-SL
E T C.

(3) *Propelling Machinery:* "PM"

General....PM-G
Steam, reciprocating, condensing:
Single....PM-RC1
Compound....PM-RC2
Triple....PM-RC3
Quadruple....PM-RC4
Steam, reciprocating, non-condensing:
Single....PM-RN1
Compound....PM-RN2
Steam, reciprocating, details:
Frame and bedplate.PM-RD/FB
Cylinders, piston, packing.PM-RD/Cyl
Crankshaft and connecting rod, crosshead and guides, walking beam....PM-RD/CS
Valve gear....PM-RD/VG
E T C.

(4) *Auxiliary Machinery:* (Engine room accessories, spare gear and stores) "AM"

General....AM-G
Condenser....AM-Cd
Pumps:
General....AM-Pu/G
Air....AM-Pu/A
Circulating....AM-Pu/C
Feed....AM-Pu/Fd
Bilge and ballast....AM-Pu/B
Fire....AM-Pu/Fi
Cargo....AM-Pu/Cg
Miscellaneous....AM-Pu/Ms
Pumping system....AM-PuS
Piping and valves, etc.:
General....AM-Pi/G
Steam and exhaust....AM-Pi/S
Feed....AM-Pi/Fd
Bilge and ballast....AM-Pi/B
E T C.

(5) *Deck Machinery:* "DM"

General....DM-G
Windlass and capstans....DM-W
Winches....DM-W
Steering machinery....DM-St
Towing machines....DM-ToM
Miscellaneous....DM-Ms

(6) *Stationary Machinery, Etc.:* "St-M"
(Not listed under "SY" or "P.")

(7) *Boilers and Boiler Plants:* "B"

General....B-G
Boiler arrangement and boiler plants....B-A
Scotch boilers....B-Sc
Watertube boilers....B-Wt
Miscellaneous boilers....B-Ms
Boiler details:
Furnaces....B-D/F
Oil burners and accesories, B-D/OB
Internal fittings....B-D/IF
E T C.

(8) *Tests:* "T"

Trial-trip reports....T-TT
Engine testing and adjusting..T-E
E T C.

(9) *Practical Problems:* "PP"

Conservation....PP-Cons
Lubrication....PP-Lb
Superheated steam....PP-SS
E T C.

(10) *Accidents and Salvage Work:* "A & S"

Notes on ships....A & S-S
Life saving....A & S-Li

(11) *Materials and Material Treatment:* "M"

Metals....M-Mt
Fuel....M-F
Timbers....M-Ti
E T C.

(12) *Piers, Docks, Loading and Discharging:* "P"

General problems....P-GP
Pier construction....P-Constr.
Freight handling....P-F
E T C.

(13) *Shipyards and Shipyard Work:* "SY"

General description of shipyards....SY-G
Storage of material....SY-M/St
Tools:
Hand....SY-T/H
Machine....SY-TM
(See also under specific work for which tools are made.)
Plate and angle work....SY-PA
Work on building Ways...SY-BW
Launching....SY-Lch
E T C.

(14) *Shipbuilding:* "Sb"

General articles....Sb-G
Shipyard reports....Sb-SY
Labor questions....Sb-Lb
E T C.

(15) *Ship Lines:* "SL"

Arranged according to firms or trade.
Description and history of ship lines....SL-H
Financial reports....SL-Fin
Trade routes and trade possibilities....SL-Tr
E T C.

(16) *Shipping:* "Sp"

General articles....Sp-G
History....Sp-H
Nautical questions....Sp-Naut
Nautical instruments...Sp-Naut I
E T C.

Designations on Third Place:

Theory....Th
Design....D
Economy....Ec
Cost data....Co
Statistics....St
E T C.

American..../Am
British..../Br
German..../Ger
Combined with any of the above.

This system has been tried successfully in a New York steamship firm. It may be of interest to note that in this particular case, the choice, designating and filing of articles from various magazines—the issues of which had been piling up for more than two years—was satisfactorily done by a clerical man without technical training.

LETTERS TO THE EDITOR

A Long Tow

The writer has read with considerable interest the article in the January issue entitled "Towing the U. S. collier *Maumee* from Mare Island to New York," by Mr. Frank A. Stanley. In this article the author states that this undertaking is the biggest on record, with the exception of towing the dry dock *Dewey* to Cavite, P. I.

No doubt this statement is correct, if the size only of the *Maumee* is considered, but in this case the number of miles towed was only 5,260, while there are other cases on record of a longer tow. In the *Commercial News* of San Francisco, under date of February 28, 1905, is given an account of a voyage of the Standard Oil Company's steamer *Atlas* towing their barge *No.* 93 from New York. This journey consumed seventy-two days and covered over 13,000 miles. The details given were as follows:

"On Sunday, the Standard Oil Company steamer *Atlas,* Captain Fenlon, having in tow steel barge *No.* 93, arrived in port, seventy-two days from New York. Both steamer and barge are equipped with the Shaw & Spiegle patent automatic towing machines, manufactured by the American Ship Windlass Company, of Providence, R. I., and but for such equipment it is doubtful if this long tow of over 13,000 miles would have been practicable. Some heavy weather was encountered on the voyage, and it was very thick for several days while in the Straits of Magellan. The *Atlas,* a tank steamer, left New York with 15,000 barrels of fuel oil in her hold. All but 5,000 barrels of this cargo was used for fuel on the way. The barge left New York with 21,000 barrels, or 1,255,000 gallons of naphtha, in addition to several thousand barrels of fuel oil that was used on the way in operating her steering gear and winches.

"The barge is fitted with four schooner rigged masts. The forward mast is used as a smokestack for the donkey engine and the aftermast is used as a smokestack for the galley. Both steamer and barge are to be employed by the Standard Oil Company on this coast. The *Atlas* was built in 1898 at Chester, Pa., and is 248 feet long, with a breadth of 40.1 feet, and depth of 22.5 feet. She carries a crew of twenty-five men. The barge is commanded by Captain Erickson, who has a crew of eleven men. The vessel was built two years ago. She is regarded as an up-to-date oil carrier. She is 280 feet long, 45 feet in breadth and 30 feet deep, and when laden with 28,000 barrels of oil has a draft of 21 feet." READER.

Refrigeration and Refrigerator Insulation on Board Ship

Referring to Mr. Llewellyn Williams' comments on my paper on "Refrigeration and Refrigerator Insulation on Board Ship," and referring especially to his criticism of the use of sheet cork for refrigerator insulation on board ship and his preference for granulated cork for this service, I may say that we have just recently finished an installation of sheet cork on the United States supply ship, No. 1, the *Bridge,* in which the cost of doing the work, together with the saving in space by the use of the higher grade insulation, was, in the judgment of the Navy Department, in favor of the sheet cork.

I think possibly that Mr. Williams does not take sufficient account of the actual cost of space on board ship in making his comments. One need not consider the cost of space under war conditions, but rather under normal conditions, to reach the conclusion that the sheet cork is the preferable insulation where it can be used. At the same time there is no one insulation or construction that is universally applicable, and while I wish to defend the statements in my paper against Mr. Williams' criticism in this instance I do not wish to have my remarks interpreted as meaning that pure sheet cork is the only insulating material that is right for every insulating problem.

Mr. Williams' statement that there are 7,500 enclosed-type machines fitted with crank case packing, some of which have been in operation for over sixteen years, and none of which has had to renew the crankshaft, due to wear in the packing space, etc., reminds me of President Lincoln's story of the man who, being accused of theft and being confronted by a witness who declared that he had seen him steal the goods, assured the judge that he could bring a thousand character witnesses who could swear and would swear that they had not seen him steal the goods. As a matter of fact, I have photographs of crankshafts from this type of machine in which the wear has been extremely serious in the packing space. I do not mean to say that every machine will invariably have this trouble, but, as I have already said elsewhere in reply to this same statement of Mr. Williams', this difficulty not infrequently arises in machines of this type that are not given careful attention.

In this connection I take the liberty of quoting from a personal letter which I received a few days ago commenting upon my paper, and in reply to a letter which I had written:

"I think that you have stated the correct situation when you said the customer probably has the trouble with the enclosed machine and not the company who built the machine. That is the very experience we have found in dozens of cases in this country, and just a few days ago I had occasion to see a machine in Minneapolis that illustrated the point. I had occasion to see the machine after it was dismantled after a five-year period of operation. The bearings, but particularly the one that is packed with the packing nearest the flywheel, were cut very much as if by a pipe die. They had apparently never been able to keep the shaft tight."

New York. ROBERT F. MASSA.

Oil Engine Nomenclature

A point of vital interest to all interested in marine engineering and motorships is the fact that proper distinction is not made between engines of the Diesel and so-called semi-Diesel type. The general misuse of the terms "Diesel" and "semi-Diesel" is now quite prevalent. In a good many instances in the description of motorships engines have been described as of the Diesel type when actually they are not of this type at all. This is not only an injustice to the builders of marine engines of the Diesel type, but also is unfair to those interested in information regarding motorships.

The term "semi-Diesel" is not a logical one, and undoubtedly the reason for its existence is the desire to give the impression that a certain type of engine possesses advantages which actually are possessed only by an engine of the true Diesel type. In the Diesel type engine the compression of pure air is carried to a sufficiently high point to insure that the oil fuel which is injected at the beginning of the stroke is ignited immediately by the heat of this compression and burns steadily without any explosive effect and at approximately a constant pressure.

In the so-called semi-Diesel engine, air only is compressed, but not to a sufficiently high point to generate

(*Concluded on page* 90.)

The Present Position and Prospects of American Shipbuilding*

Brief Summary of Handicaps Imposed on American Shipbuilders By Adverse Legislation — Effect of Present Shipbuilding Boom — Naval Construction

BY J. W. POWELL†

FEW other industries have experienced rougher going than American shipbuilding, and while the present offers much of encouragement, it is only by making the most of present opportunities and by wise legislation that its present growth can be maintained and its future development assured. From 1820 to 1830 not less than 92 percent of the import and export business of the United States was carried in American vessels, a result primarily achieved through the operation of discriminating duties and tonnage dues. With the gradual introduction of the "most favored nation" clause in the various commercial treaties, which sounded the death knell of our shipbuilding and shipping industry; with the subsequent introduction of steam for navigating purposes; with the transition from ships of wood, in which this country was supreme, to ships of iron and then of steel, for the construction of which both materials and facilities were then lacking in the United States; and with the abolition of subsidies in the Atlantic trade and the loss of tonnage, caused both by transfer and by destruction during the Civil War, the percentage of its commerce borne by ships of this nation decreased, until by 1890 a bare 10 percent of our import and export commerce was done in American ships.

Shipbuilding, needless to state, goes hand in hand with shipping. In the days of our greatness as a shipping nation the American shipyard ranked above all others, and when our shiping sank to insignificance its twin industry also reached the low ebb of its history.

Few subjects have received more legislative attention during the last twenty-five years and none has called forth more ill-advised legislation. It is not amiss to summarize some of the various laws that have been enacted since the beginning of the present century.

Shipping Legislation

By the act of July 1, 1902, Congress opened the Philippines and certain other insular possessions to the shipping of the world, instead of considering the sea voyage between this country and our island possessions as covered by the same laws as for coasting trade, which apply in the case of trade to Porto Rico and Hawaii. The immediate result was to throw the trade between these possessions in the United States into the hands of foreign nations.

In 1902 Senator Gallinger's commission completed a most comprehensive study of the shipping and shipbuilding industry and submitted to Congress a report that is an authority to this day. For the next ten years there was scarcely a Congress in which the attempt was not made to build up American shipping and shipbuilding by means of subsidies. The platforms of both political parties called for legislation to produce this result and at various times each of the houses of Congress actually approved such legislation, but because of the strenuous Democratic opposition, assisted by certain Middle Western Republicans, these laws were never finally enacted.

Toward the end of President Taft's administration the opponents of subsidy had become so strong as to be able to carry on an offensive campaign for free ships. The Panama Canal Act, passed August 24, 1912, admitted to American registry foreign-built ships less than five years old for foreign trade when owned by citizens or corporations whose managing officers were citizens, and permitted such vessels to draw subsidies under the act of 1891. Shipbuilding material was also admitted free by this same act as a sop to American shipbuilders. It also provided that no Panama Canal tolls should be charged on vessels engaged in the coasting trade of the United States.

Eight-Hour Workday for Naval Construction

Two months before this act, the act of June 19, 1912, had established by law an eight-hour workday for all contracts for the construction of vessels for the United States Navy. The immediate result of this act was to place several of the large shipyards on an eight-hour basis, which to-day is the accepted workday in this industry in many of the largest yards in this country.

In the Underwood Tariff Bill, enacted October 3, 1913, a provision was inserted allowing 5 percent discount on all duties imposed by the act on goods imported in vessels of American registry, coupled with the provision that this was not to abrogate or impair any treaty between the United States and any foreign power. This provision, which might have been of some benefit if liberally interpreted, is still in the courts, and to date no duty drawback has been received by any American importer.

Just before the outbreak of the war, the act of June 15, 1914, repealed the provision for free tolls for coastwise vessels using the Panama Canal. This act was passed on the plea of the President that, for reasons not to be disclosed, the action by Congress was necessary to the foreign policy of the United States.

Foreign-Built Vessels Admitted to American Foreign Trade

Immediately after the outbreak of the war the act of August 18, 1914, repealed the provision of the original Panama Canal Act, requiring foreign-built vessels to be less than five years old to obtain American registry, so that to-day any vessel, regardless of her age, is entitled to register for the foreign trade. This act also permitted the President to suspend requirements as to citizenship of officers, survey and inspection and measurement of foreign-built vessels for such time as he should see fit, with the result that the foreign-built vessel applying for American registry is to-day actually better off than the American-built vessels, under the laws of this country.

The act of February 25, 1915, permitted the admission of American registry and enrollment for the coast trade of wrecks on the coast of the United States or its possessions or in any adjacent waters which might be repaired in the United States, provided the cost of repairs was three times their appraised value, thus breaking down the barriers that up to that time protected the coasting shipping of this country to vessels built in American yards.

The act of March 4, 1915, known as the LaFollette Bill, legislated for the operation of vessels, greatly increased

* Paper read before the National Foreign Trade Council Convention, Pittsburg, Pa., January 27.

† President Fore River Shipbuilding Corporation, Quincy, Mass.

the difficulty and expense of operating under the American flag.

The act of September 7, 1916, known as the Shipping Bill, created a Shipping Board, appropriated $50,000,000 (£10,250,000), which is available for the Government's use to undertake the establishment of lines of shipping, and conferred on this board powers that may, in general, be described as parallel to those of the Interstate Commerce Commission.

It would be hard for a student of politics to find more ill-sorted or badly-advised legislation to achieve a given end than that briefly summarized above. The results have been negative or positively harmful and precious years have been frittered away, so that to-day in its time of need this country finds itself faced by a shortage of shipping that is placing a burden on our commerce, due to excessive freight rates, that is appreciated by a very small proportion of the population. When an 8,500-ton ship, fresh from the builder's hands at a purchase price of $650,000 (£133,000), can command a freight of almost $100,000 (£20,500) a month the consumer is paying a tax for the unwisdom of past legislation that speaks for itself.

That considerable strides have been made in shipbuilding and shipping in this country since the outbreak of the European war is a matter of common knowledge, but this growth is not so great as is usually supposed. A brief summary of statistics is interesting, as showing the results that have actually been achieved. For most of these following I am indebted to Mr. Stevenson Taylor, president of the Society of Naval Architects and Marine Engineers.

Output of Shipyards

The shipyards of the world in 1909 produced 1,600,000 gross tons of shipping, and in 1913, 3,330,000 tons, these figures representing the low and the high annual productions. A fair average for the last five years may be taken as 2,740,000 gross tons. Of this the United Kingdom produced 60 percent, Germany 12 percent, the United States 9¼ percent (including its Great Lakes shipping), and all other countries 18¾ percent. This gives the United States a five year average of about 250,000 tons, not including river craft, but including vessels building on the Great Lakes. On June 30, 1915, the world's tonnage of merchant vessels amounted to 49,262,000 tons, of which the United Kingdom owns 43½ percent, the United States 12 percent, Germany 10 percent, and all other nations 34½ percent. Mr. Taylor has combined the maximum gross tonnage of merchant vessels launched by each nation in any one of the years from 1899 to 1915 to show a maximum shipbuilding capacity for the world of 3,685,000 tons. Of this the United Kingdom's output amounts to 54 percent, the United States, including the Great Lakes, 14.6, Germany 12.4, and all other countries 19 percent.

Since the outbreak of the war the United Kingdom's output of merchant vessels is a third of its average for the previous five year period. The reports for 1916 give for the United Kingdom 619,000 tons and for all other nations 1,335,000 tons, of which the United States is credited with 520,000 tons, so that for this year the percentage of the world's tonnage produced in the United States has risen from 9½ for the five year average preceding the war to 26.6 percent. The total tonnage produced has increased from an average of 253,000 tons for the five year average to 520,000 tons, as given above.

The following table showing the production of tonnage by countries is taken from the annual Shipping Supplement of the *Glasgow Herald*:

	1916		1915	
	Vessels	Tons	Vessels	Tons
U. K.	510	620,000	600	680,000
U. S. A.	178	554,810	127	270,124
Japan	250	246,234	127	98,213
Holland	300	211,693	390	217,592
Germany	20	81,950	46	179,804
Italy	30	60,472	4	20,230
Norway	70	44,902	86	61,477
Sweden	35	40,090	33	25,927
France	10	39,457	32	41,438
Denmark	30	37,150	40	51,361
Spain	10	11,171	7	14,306
China	38	7,862	50	8,073
Russia	...	.....	13	792
	1,481	1,955,791	1,555	1,669,337

It will be noted that in spite of the feverish activity of shipyards all over the world the net increased tonnage production for the year 1916, as compared with 1915, was less than 300,000 tons.

Merchant Tonnage War Losses

The year 1916, therefore, saw inconsiderable progress in the tonnage production over the average of the previous year, while during this same period the loss of merchant tonnage has been stupendous. That 5,000,000 tons will actually cover the war loss few of those in position to be best informed will believe. From mine, torpedo and surface raiders and from perils of the sea a huge daily wastage of tonnage has resulted, so that far from the normal increase that may be expected from year to year there has been an abnormal decrease, so that to-day, were the war over, it is doubted whether 40,000,000 tons of merchant shipping would be available for the world's trade.

To-day the shipyards of all neutral nations are working to capacity. In our own country on January 1, 1917, there were 403 vessels of 1,495,000 gross tons under contract, and it is possible that the year 1917 may show for the first time in our history a tonnage production of over 1,000,000 gross tons of shipping. With high freights and tonnage shortage an enormous volume of business has been offered to American shipyards and new yards have sprung into existence on all of our sea coasts.

Under the Government's act admitting foreign vessels to American registry for the foreign trade up to September 26 last, 196 foreign-built vessels of nearly 650,000 tons have been admitted to American registry, but during the same period 261 American-built vessels of 150,000 tons were sold abroad, leaving a balance of 490,000 tons as the net increase to the American merchant marine from this source, or less than the tonnage constructed during the past year. Practically all foreign countries have to-day forbidden the transfer of vessels to foreign flags. In England the building of merchant vessels for foreigners is forbidden by law until the end of a period of two years after the close of the present war. The net result is that foreign shipowners have been driven to the United States as their principal market, so that to-day of the nearly 1,500,000 tons of shipping here on order, over one-third is for foreign account. So far as our merchant marine is concerned, it is therefore unlikely that the year 1917 will see an increase of over 750,000 gross tons.

Five Years of Prosperity Certain

Mr. Stevenson Taylor has figured, allowing for the probable production and probable destruction, a total deficit in the world's tonnage at the end of 1918 of 6,500,000 tons. It is my belief that this deficit will be much nearer 10,000,000 tons and that at maximum capacity the shipyards of the world will hardly be able to meet the probable requirements for a period of at least three years after that date. It therefore appears probable that the next five years will show a continuation of the growth of our shipbuilding industry, and while high freight rates remain, a lesser but corresponding growth in the shipping under our flag.

At the present time shortage of labor and of shipbuilding material are controlling factors and the growth of production of ships is in the ultimate dependent on the training of skilled shipbuilding labor. The actual increase in American shipping will be controlled for some time to come by these factors and production will only be considerably increased by the careful training of artisans and the co-operation by manufacturers of shipbuilding material and builders to serve this important industry.

Shipbuilders' Attitude Toward Naval Preparedness

In considering the growth and future development of American shipbuilding it is impossible to ignore the position of most of the older shipbuildng companies in connection with the movement for national naval preparedness. The larger yards on the Eastern coast have to-day given up about three-fourths of their capacity to naval contracts, and those yards that have been engaged in Government business stand ready to work to the limit of their facilities in producing vessels for the Navy's requirements. It is in the face of this fact that Congress has been asked to appropriate $12,000,000 (£2,460,000) in addition to the $6,000,000 (£1,230,000) appropriated a year ago to fit out a number of navy yards for the construction of capital naval ships. This legislation will probably shortly become a law, with a result that we shall see the National Government embarked on a shipbuilding venture running into hundreds of millions of dollars. The labor for this work can only be drawn from private yards and will primarily come from those yards at present building Government vessels. In addition to the hampering weight of governmental red tape and inefficiency of productivity, all this labor so diverted will be further decreased by an amount equivalent to the thirty days' annual leave granted every employee in navy yards.

Favoritism Towards Navy Yards

The Secretary has stated to the Naval Committee that he desires navy yards to be equipped to build one-third of the vessels required for the Navy, working the laborer a single shift of eight hours, and then proceeds to call for equipment for navy yards that would provide for the construction of a continuous program as large as that upon which the Government has now embarked. It is significant that never since the battleship *Connecticut* was begun at the New York Navy Yard in 1902 has that yard been without a battleship under construction. Some years only a single battleship has been included in the Naval Appropriation Bill, but always Congress has taken care of its own, and the country at large should take pause and consider the effect of a half dozen arsenals fitted out to carry on this work. It is my belief that this can only result in the creation of a powerful political lobby to carry on the campaign for naval preparedness, whether or not the present need therefor may continue. It is more than possible, even probable, that with this large increase in naval shipbuilding facilities and following the completion of the naval program, great pressure will be brought to bear to expend the $50,000,000 (£10,250,000) appropriated for the use of the Shipping Board in the building of merchant ships in Government yards, and the stupendous proportions to which this phase of Government ownership and operation may develop require the most careful public consideration.

I am very frankly opposed to this policy. Certain shipyards have offered to build vessels of this naval program on basis of cost and percentage, both overhead charges and profit to be determined by the Federal Trade Commission, and our company has offered to build in competition with the navy yards and at their price, under the supervision of public accountants with a view to disclosing to the public the utter extravagance and wicked wastefulness of this proposed Government expenditure. It is a fact that it is impossible to tell and nobody knows to-day what is the cost of building a ship at a Government yard. Through a system of bookkeeping that is little less than wilfully deceitful, figures are turned in as representing costs that have but a vague resemblance to the expenditures actually entailed in warship construction, but the taxpayer pays the balance of the bills, and so long as he does not know what this balance is this unwise expenditure can be expected to continue.

Shipping and shipbuilding are so intimately connected that consideration of the future of one necessitates the similar consideration of the other. In the past these two industries have been dependent on Great Britain for marine insurance and for the classification, which is a prerequisite for this insurance. For the industry to really take its proper place, it has been essential that it achieve independence in both of these directions. American insurance companies have become interested in marine insurance to a far greater extent than in the past, and to-day it is possible to write policies running into seven figures, both for builders and for marine insurance. The rehabilitation of the American Bureau of Shipping, a purely American organization for the classification of vessels, has marked a further step in advance. It is now possible for the American shipbuilder and shipowner to deal with those novel problems that continually arise in this intricate engineering science, first hand, with experienced principals, thus eliminating the mortifying necessity of referring such questions for settlement abroad.

Importance of the Shipping Board

By far the most important event in the development of our merchant marine that has occurred in recent years is the appointment by act of Congress of a United States Shipping Board, marking a radical change in our previous policy with regard to American shipping. While shipping has always come in for a considerable amount of attention at the hands of certain departments of the Government, it is thus for the first time elevated to a position of prime importance. As time goes on, and as the powers of this board are enlarged, and as its experience increases, there is every reason to expect it to exercise the same dominating influence in the shipping industry that the Interstate Commerce Commission has achieved in matters affecting railroad transportation. For the first time in our history there will be a tribunal important in the eyes of the public and before the National Government that is capable of representing the twin industries of shipbuilding and shipping.

The future of these industries will be dominated by the policy and personnel of this Shipping Board. A considerable growth and a maximum of activity are assured for a period of perhaps five years to come, but the real test of our development will be met when tonnage requirements have been caught up, in some measure, to the world's demand.

It is conservative to state that the last twelve months have seen an increase of 25 percent in the wages paid in American shipyards. The same twelve months have likewise seen a very considerable decrease in the efficiency of the workmen, due to the fact that the small number of skilled workers have been spread out over a much larger number of shipbuilding establishments. Since the beginning of the war the average cost of material entering into the construction of ships has increased from 50 to 300

percent, so that to-day the cost of construction in American shipyards is not far from double what is was at the outbreak of the war. So far as material is concerned, what difference exists to-day between the cost in the United States and abroad is probably in favor of the latter, but on the score of labor costs and efficiency it is probable that American yards are further behind them than at the outbreak of the war. Full investigations carried out some three years ago show that, at that time, average wages in shipbuilding in Great Britain were 50 percent less and the net output per wage earner was 14 percent more than in the American yards. When peace returns it is impossible to suppose that our industry with its much higher wages will be able to compete any more successfully than it did before the war with the principal foreign shipbuilding countries, and it is my belief that remedial legislation must be enacted to equalize this difference if the country is to maintain and render more secure the position that it may hope to achieve in the next five years.

But the cost of building is only one phase of this important subject. The cost of operation under the American flag is immensely more than under foreign flags, and it is conservative to say that 40 percent is not too high to figure this average excess.

High Cost of Operating Vessels Under the American Flag

Starting with the British and working down the scale to the Japanese, this difference is so great that the best designed and best built American ship, if relieved of all costs for insurance, interest on investment and depreciation, would not under normal conditions survive under competition with vessels flying foreign flags. That this condition will again be true when the world has returned to days of peace cannot be doubted, and it is my belief that unless steps are taken to counteract this difference a large percentage of the tonnage being built for the American flag will eventually pass under the flags of other nations.

Shipbuilding and shipping are like the steel business, businesses of great extremes. The present enormous boom, which promises to last for a considerable period, will be succeeded by an equally severe depression, and the time for the study of this situation and the application of the laws that will minimize the effect of the slump and that will permit the continuing of our progress is the present.

The selection of any particular method for achieving this result is less important than the selection of some definite method. Given this point settled there remains the permanent practical problem of its application to equalize the cost of building and operating American vessels, as compared with the foreign competitors. Whether this be done by direct subsidy, by mail subvention, by discriminating duties or by taxes, it must be clearly recognized that it is only by overcoming the differences in construction and operation in this country and abroad that this industry can achieve and hold its proper place, and if the American people decide that they need an American-built and American-owned and operated merchant marine, they must face this payment as the price exacted of them by the conditions under which we live. We cannot hope to surround our shipping with all sorts of restricted legislation and still operate our ships on the basis of foreign costs. We cannot hope to build our ships in this labor market with its American standard of wages in competition with the cheaper wages on the other side. In spite of the huge amounts of modern capital that has gone into the American shipbuilding plants in the last three years, which has placed them in the van in point of equipment in the entire world, this business is too international in its character and our foreign rivals have been too thoroughly waked up by the war to make it more than an idle dream to suppose that any superiority of design or methods of building can overcome the basic disadvantages of our situation, and it is here that the opportunity is waiting to the hand of the Shipping Board. If it can study and solve this problem and can secure the enactment of necessary legislation, our place as a shipbuilding and shipping nation will be secured and this board will have achieved a right to stand as one of the most valuable of our Government. And in an honest effort that we know will be made to achieve this end, the Shipping Board may count on the full and hearty support of our industry..

Oil Engine Nomenclature

(*Concluded from page* 86.)

sufficient heat to ignite the fuel which is injected at about the beginning of the stroke into an unjacketed combustion chamber connected with the interior of the cylinder and termed a "hot bulb" or "hot ball," the walls of which have a sufficiently high temperature to ignite the combustible mixture formed by the injection of oil at about the beginning of the stroke. The combustion is obviously more or less of the nature of an explosion, with a considerable rise in pressure.

This type of engine is like an ordinary gas or gasoline (petrol) engine in that it is provided with an ignition apparatus which takes the form of the hot bulb or hot ball and differs from the ordinary gas engine in that the fuel is not injected until shortly before the beginning of the working stroke. On this account a somewhat higher compression can be employed without danger of back firing. Some outside means for heating up the hot bulb or hot ball are required to secure ignition before such an engine can be started, and of course the economy involved in the high compression of the true Diesel type of engine cannot be secured with the lower compression of the hot bulb or hot ball engine.

Hot bulb or hot ball engines are the terms originally used to describe what is now often called a semi-Diesel engine, and these terms are still almost universally used among those who are technically familiar with the subject. Since this type undoubtedly possesses merit and has a wide field of use, where short hours of service and other circumstances, particularly with smaller powers, prevent the advantages of the true Diesel type from effecting a total in the cost of operation commensurate with the higher first cost, it would seem in the end it would meet with greater success if it sailed under its true colors and the term "semi-Diesel" were discarded in favor of the "hot ball" engine. In this case the character of the engine referred to will always be plainly understood.

A. E. Ballin,
Vice-President and General Manager, McIntosh & Seymour Corporation.
Auburn, N. Y.

Opportunity for Apprentices at Fore River Yard.—Apprentices at the Fore River shipyard are given every opportunity for advancement by taking up drafting work after having served an apprenticeship in the yard. On March 15 an examination will be held for the purpose of selecting applicants among the yard apprentices for service as apprentices in the hull and engine drafting rooms. The examination is open to all apprentices who have

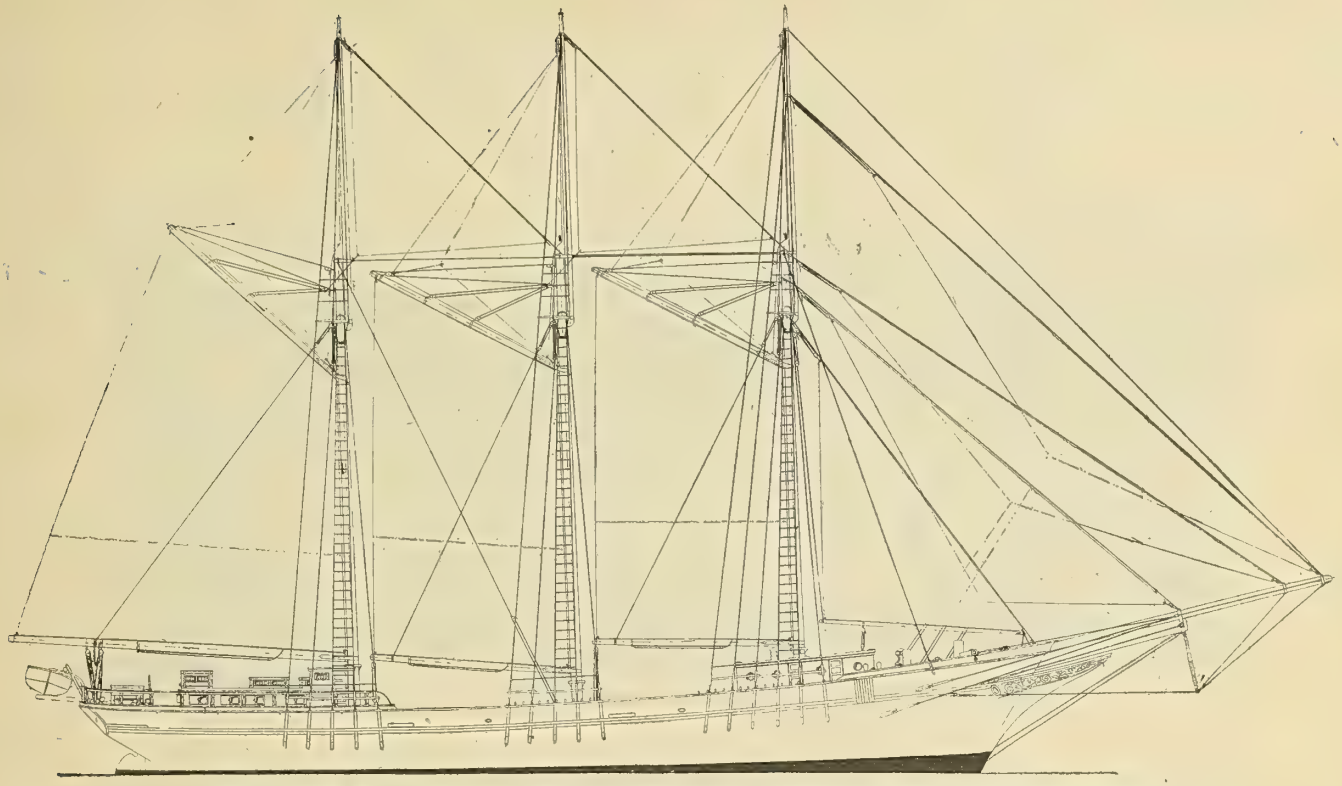


Fig. 1.—Sail Plan of Auxiliary Schooner, Designed by T. Murray Watts for Spanish Owners

served two years in trade work in any department in the plant. The examination will establish an eligible list, from which all future vacancies will be filled. Successful applicants will be required to serve a six months' term of probation.

Auxiliary Schooner Jose Juan Domine

Fig. 1 shows the plans of a 150-foot wooden auxiliary schooner now building by the Valencia Ship Building Company, of Valencia, Spain, for Romani y Miquel, of Valencia, Spain, from designs by J. Murray Watts, naval architect, Philadelphia, Pa. This vessel will be used in trading between Valencia and the Spanish-African colonies and is adapted for carrying barrels of wine, raisins, etc. She has a cargo capacity of about 450 tons and is propelled by a 200-horsepower Diesel engine.

The vessel is built throughout according to Lloyd's requirements and is rigged as a three-masted schooner. Besides the main propelling engines, there is a complete outfit of auxiliaries, including a 10-kilowatt electric plant, which operates the electric capstan and electric winches. The name of the vessel is *Jose Juan Domine*, and she hails from Valencia, Spain.

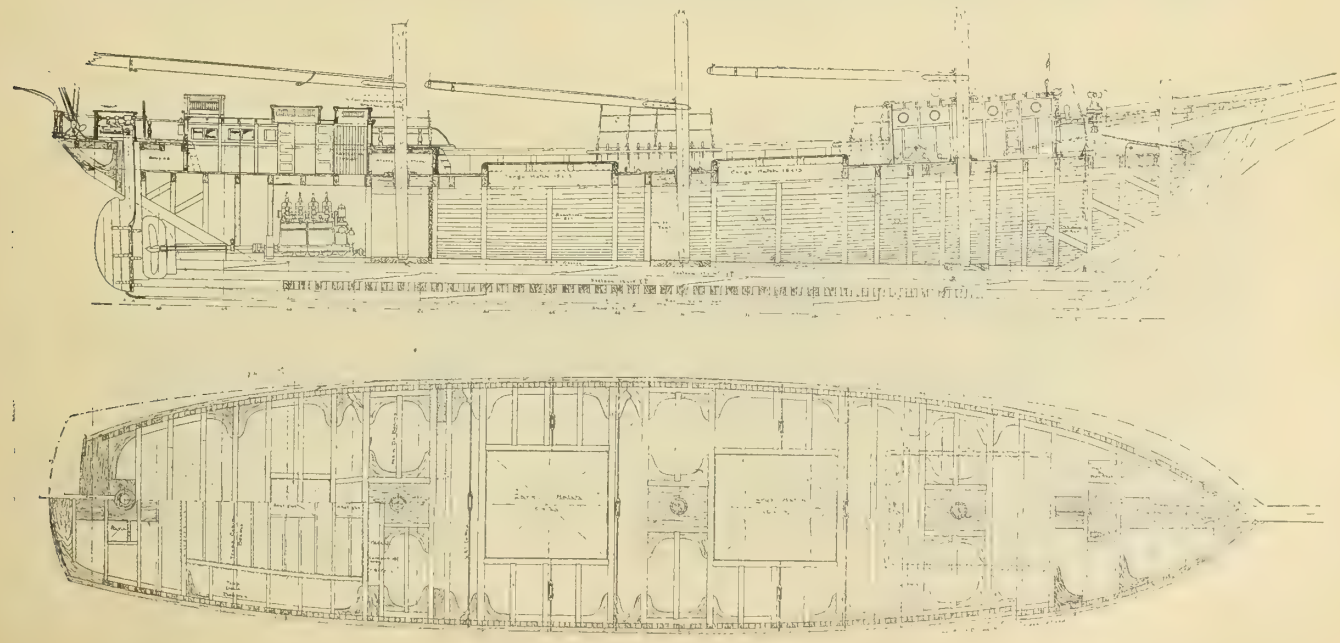


Fig 2.—Inboard Profile and Deck Plan of Auxiliary Schooner *Jose Juan Domine*

BRITISH SHIPYARD AND REPAIR PLANT IN CHINA

Hongkong & Whampoa Dock Company

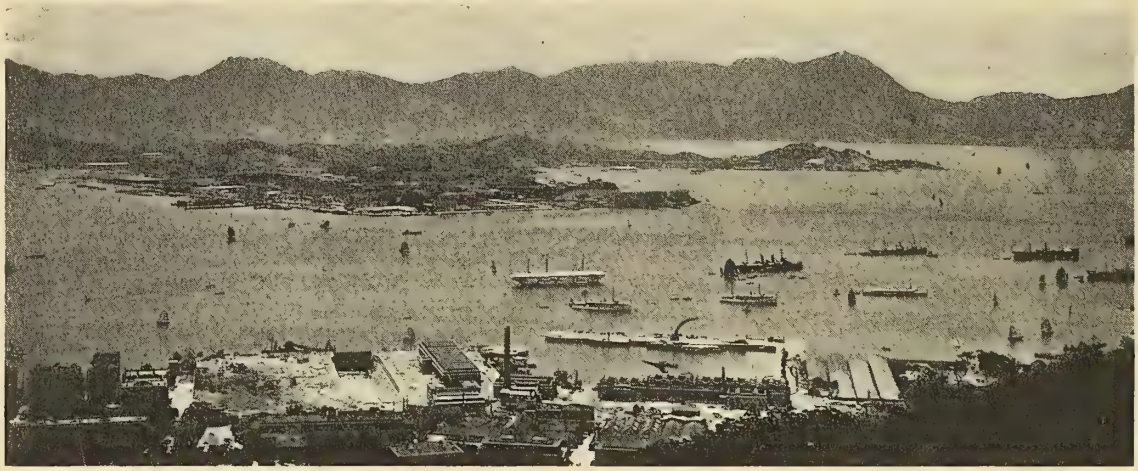


Fig. 1.—Harbor of Hongkong—Works of the Hongkong & Whampoa Dock Company in the Foreground

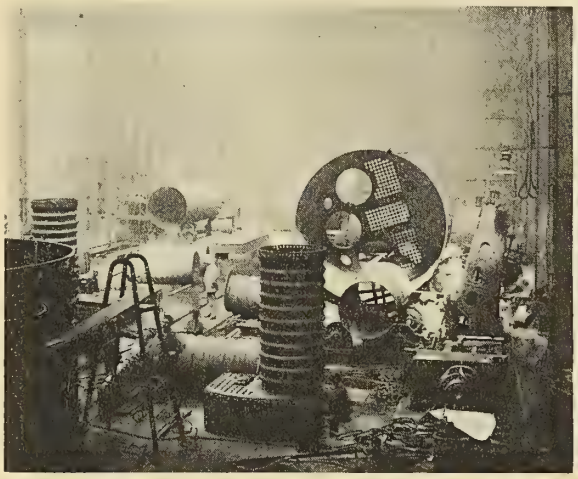


Fig. 2.—Boiler Shop

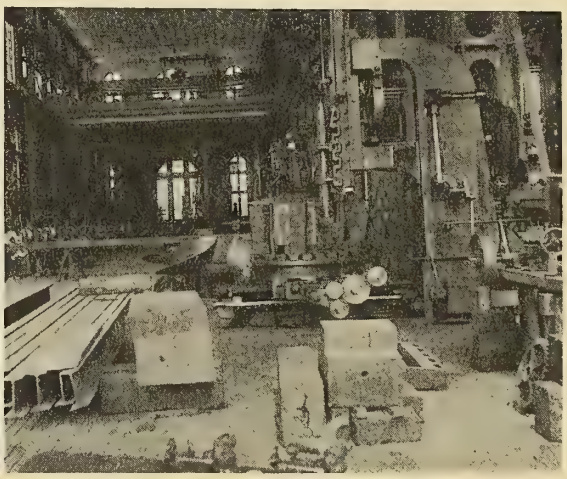


Fig. 3.—Machine Shop

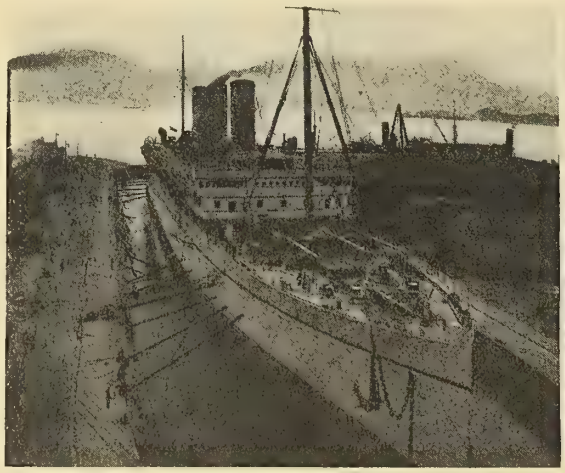


Fig. 4.—Dry Dock

Fig. 5.—Building Ways

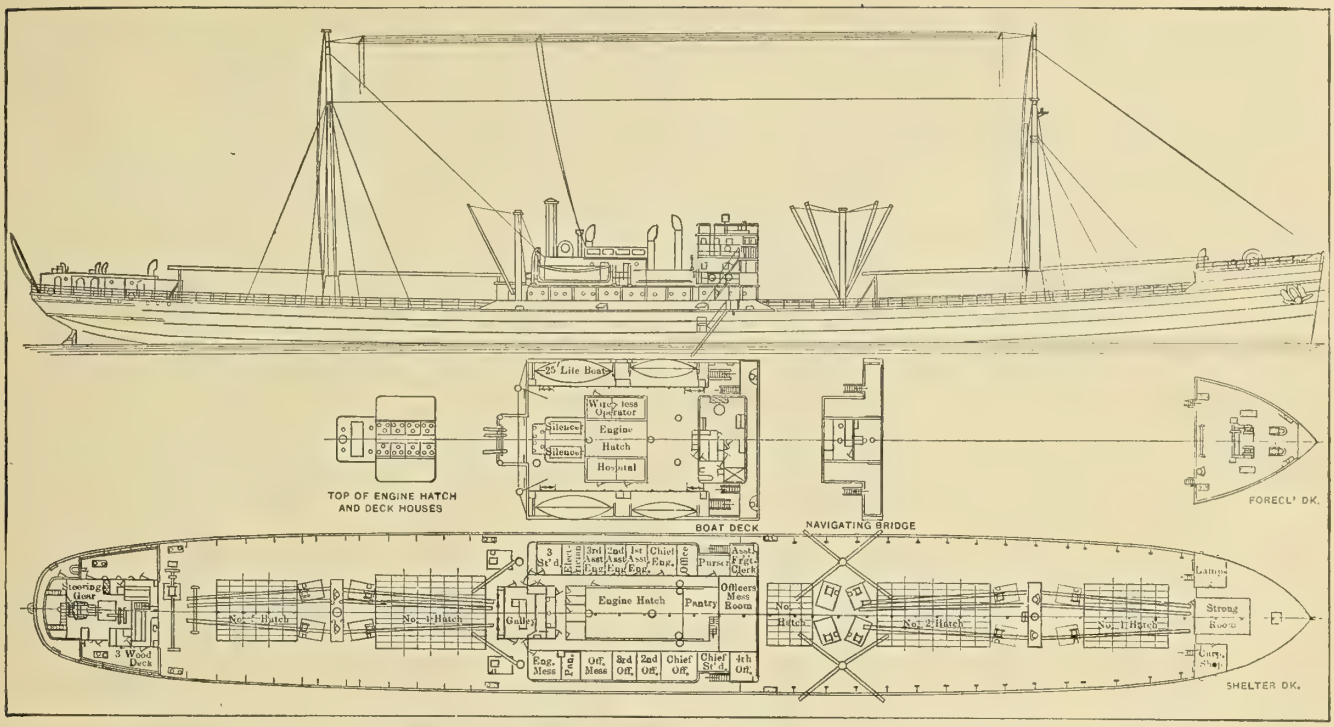


Fig. 1.—General Arrangement Plans of First Large American Commercial Motorship

Large Motorship Building at Cramp's

American Licensees of Burmeister & Wain Marine Diesel Engines Begin Construction of First Large American Commercial Motorship

TO the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa., belongs the distinction of commencing the construction of the first large commercial motorship of the pure Diesel type in the United States. As announced a year ago in MARINE ENGINEERING, this firm obtained the exclusive license for the manufacture of Burmeister & Wain engines for marine purposes in America, but it is only recently that they have been in a position to actually start the new work. Due to the system being so radically different, as well as the uncertainty of the material and labor markets, it has been decided to build this first vessel as a stock boat, to be disposed of later, when a fair cost figure can be determined.

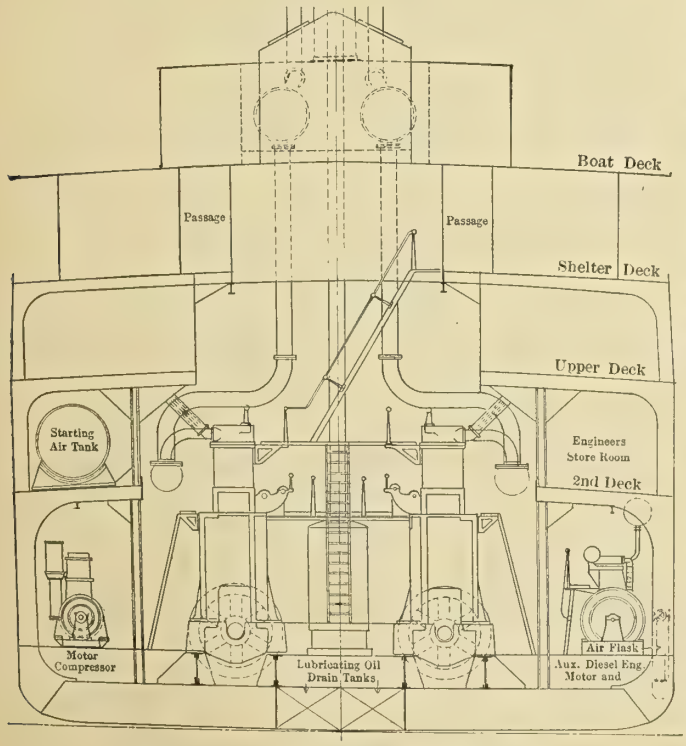


Fig. 2.—Section Through Machinery Space

To facilitate construction the three auxiliary engines, without their generators, and the maneuvering compressor, without its motor, are being obtained from the Copenhagen firm. All main and auxiliary machinery, as well as steering gear and deck machinery, will be in strict accordance to Burmeister & Wain's designs, or practices. Also the vessel is being built to meet the special requirements of Lloyd's for this particular class of work.

The outside dimensions and displacement are the same as that of several steam vessels already built and under construction for W. R. Grace & Co. at the same yard.

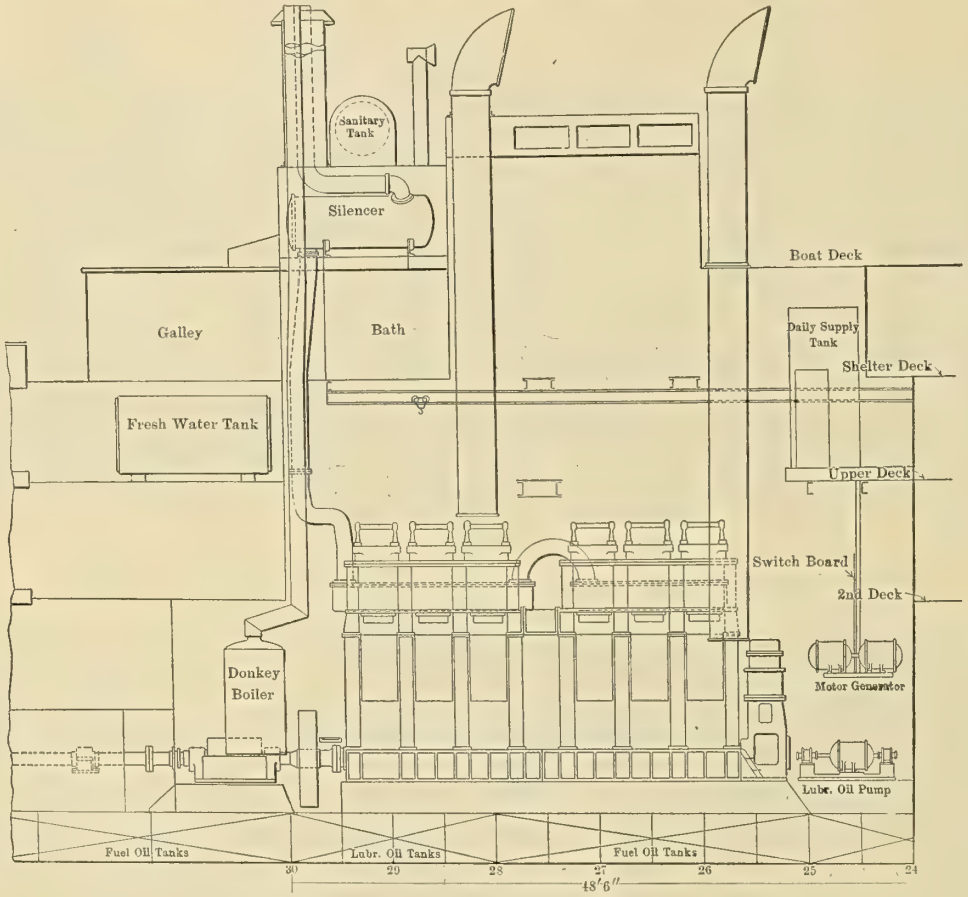
The vessel has the following dimensions:

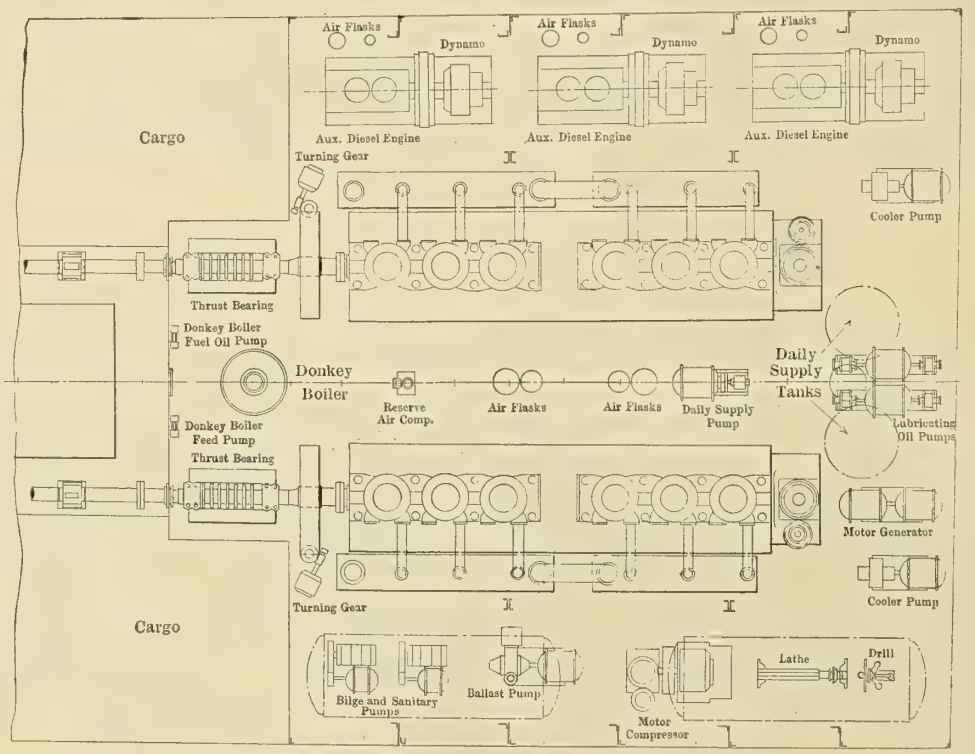
Length overall	420 feet 6 inches
Length between perpendiculars	404 feet 6 inches
Breadth molded	53 feet 9 inches
Depth molded	36 feet 9½ inches
Normal displacement, at 26-foot draft, tons	12,100
Maximum displacement, at 28-foot, 4½-inch draft, tons	13,340
Deadweight capacity, at 26-foot draft, tons	8,348
Fuel oil capacity, inner bottom, tons	1,100
Capacity of cargo holds, cubic feet	453,400

Compared with the steam vessels the cargo hold capa-

FIRST LARGE AMERICAN COMMRCIAL MOTORSHIP

Building by Wm. Cramp & Sons Ship & Engine Building Company





Figs. 3 and 4.—General Arrangement of Machinery Space

city has been increased about 8 percent, and the deadweight capacity by 118 tons. Due to the Diesel vessel requiring less than one-third as much fuel oil as the steam for a given run, the cargo capacity, in tons, actually is very much greater. Taking for an illustration a voyage where the steam vessel would require 1,600 tons fuel to be carried for the round trip the Diesel-engined vessel would require only 500 tons, with the cargo carrying capacity increased accordingly.

The arrangement of the deck winches and hatches is shown in Fig. 1. The winches, of which ten are 5 tons capacity and four 3 tons capacity, are to be electrically driven, as well as the anchor hoist and steering gear.

The engine room arrangement is shown in detail in Figs. 2, 3 and 4. The propelling machinery consists of two six-cylinder, four-stroke engines, of Burmeister & Wain design, with a cylinder diameter of 24 13/16 inches and a stroke of 37¾ inches, developing a normal total indicated horsepower of 3,100 at 130 revolutions per minute. Each engine drives its own three-stage air compressor for fuel injection air, stored at about 900 pounds in flasks located between the engines, there being one working and reserve flask for each engine.

On the port side are three auxiliary engines, each having its own compressor and flasks and each driving a 60-kilowatt, direct-current dynamo, running at 300 revolutions per minute, supplying current at 220 volts. On the starboard side is a motor-driven, two-stage compressor for storing the two large air tanks to about 350 pounds for starting the main and auxiliary engines. This is only run when maneuvering is to be done or likely to be done, the excess air being discharged to an air silencer under the engine room floor.

The daily supply pump lifts the oil from the inner bottom tanks to the daily supply tanks located in the engine room hatch. Each large tank is of sufficient capacity to run the vessel for twelve hours, each being drawn on alternately. Any sediment or water is drawn off to a cofferdam located under the tanks. The small tank noted in the middle is for carrying a lighter oil for starting up and shutting down the auxiliary sets should the main oil supply be very heavy.

The small motor-generator set is for converting the 220 volts to 110 for lighting purposes. It also acts as a steadying effect on the lights when the winches are being operated.

There are two water-cooling pumps and two sets of lubricating pumps, one of each set being kept as a spare. Each lubricating pump set consists of two gear pumps driven by a common motor. These are so connected to the main units that should one pump fail the other will supply sufficient oil for the two engines.

Two motor-driven combined bilge and sanitary pumps and one motor-driven ballast pump are also supplied.

The exhaust gases from main engines are led to manifolds, jacketed by water discharged from the main engines, and through lagged piping to two silencers located in silencer house on deck. These silencers are also lagged and provided with coils for the heating of the sanitary water. The main outside exhaust pipes are placed on either side of a dummy stack. This latter ventilates the silencer house and contains the exhaust pipes from the auxiliary engines and the boiler stack. The main and auxiliary engine exhausts are separate, so that the condition of any one can be independently and readily noted.

Eight vessels have been completed by Burmeister & Wain, of Copenhagen, which have the same main engines and auxiliaries as the vessel here described. These are the *Malakka, Tongking, Panama, Australien, Columbia, Chili, Peru* and *George Washington,* whose excellent performances assure the future success of this motorship.

Wooden Motorship State of Oregon

Two Wooden, Passenger and Freight Vessels Building at Seattle to be Fitted With Heavy Oil Engines

BY B. W. BRINTNALL

THE Pacific Alaska Navigation Company is about to launch at its yards on the West Waterway in Seattle, Wash., the wooden motorship *State of Oregon,* the first of the "State" line, of which the *State of Alabama,* which will immediately follow the *State of Oregon* on the ways, will be the second. These motorships represent a new type of vessel, being the first wooden passenger and freight ships to be entirely powered with heavy oil engines.

The Alaska Pacific Navigation Company was incorporated last spring, with C. A. Burckhardt, president, and R. M. Semmes, vice-president and general manager. They went to work at once establishing a yard, and the keel of their first ship was laid on May 1. The very best of winter cut Douglas fir has been used in the construction, and the surveyors of Lloyds and the Bureau of Veritas, who have watched the material and workmanship, have not hesitated to give the vessel the highest class in the societies which they represent.

The ship is 233 feet long over all, 216 feet between perpendiculars, 42 feet molded beam, 23 feet molded depth, and will have a carrying capacity of a million and a half feet of lumber. She is built with two decks, a forecastle and after deck house, with a clear run between, and deck officers' and wireless quarters on the bridge deck on the after house. There will be accommodations for 45 first class passengers and 55 second class passengers. The cost complete will be approximately $225,000 (£46,200).

The vessel will have two masts, which will carry two cargo booms each. Electric equipment will be fitted throughout except the steering gear, which will be both hand and hydraulic. Propelling machinery will be two four-cylinder Southwark-Harris valveless heavy oil engines of 625 indicated horsepower each. The engines will be right and left hand and will run at 200 revolutions per minute. Each engine will have four cylinders, 14 inches diameter by 21-inch stroke, driving cast iron propellers 7 feet in diameter. They will be fitted with mufflers, and will exhaust into a stack, which will also serve as funnel for the water heater.

Fig. 1.—Motorship *State of Oregon*. Length Over All, 233 Feet; Beam, Molded, 42 Feet; Depth, Molded, 23 Feet; Horsepower, 1,250

Two 40-horsepower generators to furnish power to the auxiliary machinery and a 7-kilowatt light generator, all burning oil, will be located on the 'tween deck aft of the engine room hatch and in the same space. Lubricating and fuel oil is carried in tanks both abeam and aft of the main engines. The cargo booms will be served by 15-horsepower motors driving one-man winches, which were specially designed under the direction of Mr. Semmes. There is a combined electric anchor hoist and capstan fitted with 25-horsepower motors, which have a 30-minute rating. It is geared to lift both anchors and chain, and is fitted with double heads to handle mooring lines.

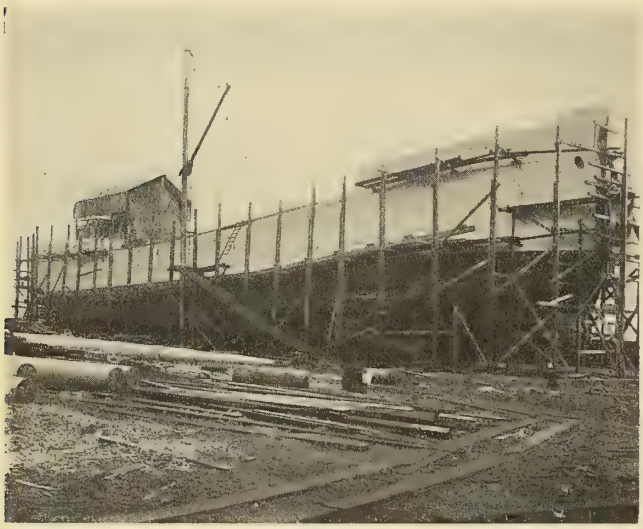


Fig. 2.—Motorship *State of Oregon* Before Launching

The timbers worked into the hull are all in as long lengths as possible. The main keel and keelsons are 24 inches by 24 inches and run in lengths up to 114 feet. The main keel and the top keels are through fastened with 1½-inch iron and 16-inch by 24-inch shoes, and the sister and top sister keelsons are through and side fastened with 1½-inch iron.

The stem is 24 inches by 42 inches, the stern post 24 inches by 36 inches, and the apron 20 inches by 36 inches. The floor pieces are 12 inches by 22 inches, and the frames run out to 11 inches by 12 inches at the sheer plank. Three breast hooks of natural fir knees no less than 12 inches sided, with extra long arms, are fitted in the bow to accommodate the angle of the frames. Pointers have three sets forward and two sets aft, molded from 18-inch timbers fitted close to the face of the ceiling. The counter pointers where they connect against the apron and deadwood have natural crook knees with through bolt fastening where

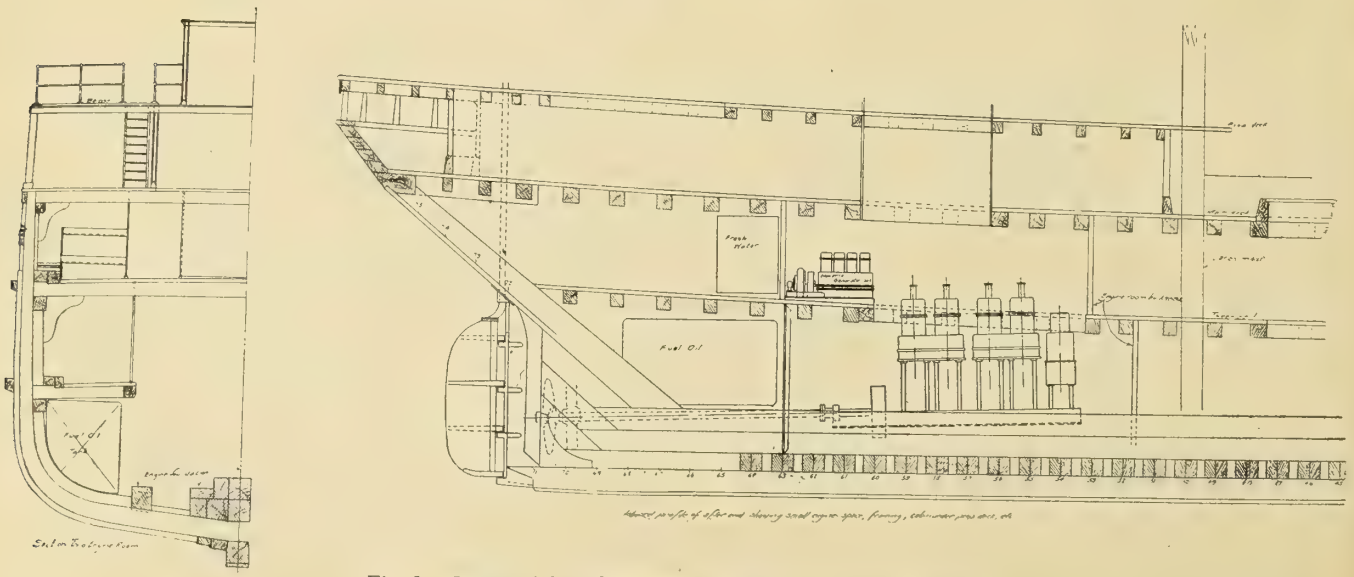


Fig. 3.—Sections Through Machinery Space of *State of Oregon*

practicable. Knees supporting the main deck beams are 12-inch sided and through fastened to every beam. Knees for the 'tween deck beams are 10-inch sided.

Frames under the main engines are filled in solid with 14-inch by 24-inch fore and aft timbers extending 8 feet beyond the engine bed, through fastened to the solid framing. The engine room hatch is 16 feet by 11 feet and extends through to the boat deck with customary skylight and gratings. The hatches in the main deck for cargo handling are 16 feet by 20 feet, and those under them in the 'tween deck are 16 feet by 24 feet.

The propeller struts will be cast steel. The rudder is of the steel plate type with steel forged stock with steel pintles working in bronze bearings and a floating bearing on the main deck. A steel collision bulkhead is fitted on the forward side of frame No. 5 and a second steel bulkhead is at the after end of the engine room at frame No. 63.

The first class passenger accommodations, social hall, dining saloon and the purser are located in the after deck house. Engineers' and oilers' rooms are in the 'tween decks over the engine room, and the stewards' crew are in the after 'tween decks. Deck crew and steerage passengers are located in the forecastle.

All fittings and equipment are of the very best to class A1 at Lloyds. Mr. Semmes, general manager of the company, is a man of wide shipping experience, and he has personally overseen all of the designing and construction.

Why is a Lightening Hole?

Troubles With An Inspector Involve "Old Mac" in a Discussion of Lightening Holes

IT was Monday and raining. Old Mac had not gone out at noon. He ate his lunch with a look of disgust on his face. The owner's inspector, who is now known as "Old Man of the Sea" and who is about as welcome in the drawing office as the measles would be in an orphan asylum, had been stirring things up again. The very first day he came in the office he and Mac had a set-to and Mac easily got the best of it except that after it was all over the chief cautioned him not to do it again, because we do a lot of repair work for the company that the inspector represents and have been cultivating them for years. He explained that we had been forced to take this ship pretty much as it was handed out to us and that a little trouble or lost time in the drawing office could be charged up to expense or advertising, as had numerous cigars, etc., already been charged.

To cultivate "Old Man of the Sea" was the last thing in the world that old Mac would want to do, but he was loyally doing his best. He had practically to teach the business, from beginning and without giving offense, to an unwilling, dignified and suspicious pupil whose intellect had already been strained beyond the elastic limit. Some job!

All the trouble started over limber holes. The contract 'midship section calls for 2½-inch diameter limber holes. We have a 2 5/16-inch punch that was made some time ago for a special job. Mac explained that he would use this punch instead of burning out the holes because it would make a better and a cheaper job. "Old Man of the Sea" agreed to it, and when the keel, floor and longitudinal plans were traced, 2 5/16-inch limber holes were shown.

"Old Man of the Sea" had always insisted on a heavier plate or angle whenever there was an opportunity. Weight costs money, and he figured that he was getting something for nothing. Changes are generally objectionable and Mac remonstrated, but yielded under pressure. The lines for this boat had been gotten out by a consulting naval architect and the responsibility for over-draft was not ours.

"Old Man of the Sea" all of a sudden got it into his head that the boat would run heavy. He talked to everybody in the yard, and maybe someone had given him a wrong steer. He may have seen some of the steel invoices. They were about 20 percent heavy because we had run in a lot of extra spares for stock because the market had gone up and was still going up. At any rate, he came in one morning all primed and ready to cut out a lot of weight. He wanted to get the bilge filled out in the loft. He was turned over to the chief, who told him that we had gone too far with ordering material to do this now, and besides, the contract lines had to be followed. Then he wanted to change back some of the increase changes he had made. The chief had his John Henry in the alteration stamp for these and intimated that a change like this would have to be charged up in a bill for extra work. Then he lit on to lightening holes. The contract says lightening holes will be cut as shall in the judgment of the company's inspector be considered proper for lightening the work and for access. "Old Man of the Sea" had us, and the chief turned him over to Mac. He wanted all lightening holes increased 10 percent. The limber holes must be 2½ inches in diameter.

Mac tried to recall to him that he had given his consent to use the 2 5/16-inch punch. This was not in the alteration stamp and he would not remember it. Mac asked him how much he thought the difference in weight per hole amounted to. He said he did not know exactly, but that there were an awful lot of limber holes in the ship. Mac wanted to ask him if he had figured on how many spoonfuls of salt would be carried in the galley, but instead he called Red Stewart over and told him to make the desired changes.

All this happened last Saturday—payday—a good day for Red. Red is well built, dresses well and has it on us all when it comes to making a hit with the girls. He had a good day and a couple of hilarious nights ahead of him. He was optimistic, and a disagreeable job like rubbing a tracing did not worry him then. When quitting time came he had not finished, however, and the job was left over until Monday.

This morning, blue Monday and raining, Red came in tired. He had entirely forgotten the office until a painstaking widowed mother had persistently routed him out of bed and hurried him off to work. His optimism was gone. He looked at the limber holes to be changed and started to count the number that he would have to rub out. Before they were all counted he got to thinking about Saturday night, then Sunday and Sunday night. Then he remembered the limber holes; 2 5/16 inches had to be changed to 2½ inches and the surrounding work on the

tracing patched up again. An idea! Why not put in a good big spare limber hole and let "Old Man of the Sea" use it up to suit himself?

There was a bare space up in the corner of the tracing and here he penciled in a large circle and labeled it, "Spare Limber Hole (To Cut)." This done, he again remembered Saturday night and Sunday and then Sunday night. Then he remembered the limber holes. He looked at the spare hole for a while and then slipped out for a smoke in order to collect himself and quiet his nerves.

In came "Old Man of the Sea." He had an idea, too—one that he probably got out of a book over Sunday. He wanted every lightening hole calculated and increased to the limit. He had to see the tracing of the floors. Mac took him over to Red's board. "Old Man of the Sea" started to explain his new and marvelous idea, but stopped short and wanted to know what the spare limber hole meant. Mac looked at it and smiled. "Old Man of the Sea" was enraged and stalked out of the office. He went down stairs and told the higher-ups that the drawing office was out of date and undignified, and that a man holding the important position he does should not be trifled with.

Mac sat down, watched "Old Man of the Sea" disappear, looked at Red's spare again, and then picked up an eraser and rubbed it out. He went over to his own board and when Red came in later the spare was gone and everything was serene. Just before noon the secretary came up and in a very nice way asked Mac to do his best to get along with "Old Man of the Sea." No wonder Mac was disgusted.

He finished his lunch, got up and looked out of the window. It was still raining. He took a look at Red and smiled. Then he spotted the kids.

"Hey, kids! Come over here; your education is being neglected.

"Why is a lightening hole? I want you to get this because, if you ever get cornered and have to bluff, try lightening holes. People differ as much about lightening holes as they do about horse races, and the less a man knows about the business the bigger bluff he can put up about lightening holes.

"Now a lightening hole was originated to save unnecessary weight and to give access and ventilation to portions of the ship that would otherwise be inaccessible. A line of holes oftentime serves as a passage for pipes, etc. By the way, if you ever lay off any lightening holes in the cramped spaces of the stern or bow framing, keep them in a fair line so that a man does not have to divide himself in pieces to get through. In oil spaces having swash plates, half round holes are often cut and take the place of ladders.

"Burning is about the cheapest way to cut out a lightening hole, although it leaves a hard, ragged edge that has to be chipped. When dies are used, a limited number of sizes have to be followed, but now any shape of hole can be burned out.

"Theoretically a member can be cut or lightened to the extent that its strength through the hole is no less than the strength through a line of non-watertight rivet holes. This rule is often hard to apply practically. A rough rule and one that applies well as a first approximation, at any rate, is to cut out about half the width of the plate between the toes of the connection angle. When the largest possible lightening hole is not large enough for access, and access is necessary, a reinforcing plate or doubler is riveted to the plate and around the hole to make up the strength cut out by the larger hole. Lightening holes should be kept clear of butts of the shell, inner bottom and keel unless access is necessary. Don't show a lightening hole in a watertight or oil-tight bulkhead or floor. Yes, it has been done.

"Eighteen inches diameter by 23 inches long is a good, comfortable access hole; 15 inches by 18 inches will do, and a boy can get through 12 inches by 15 inches. Sometimes, at the ends of longitudinals for instance, lightened plates can be replaced by brackets without loss of strength and with better access.

"In addition to lightening holes, limber, vent and drain holes are cut. In wood ships a channel is cut in the bottom of floor timbers against the outside plating and a chain is laid for the length of the ship in this channel before the planking is put on. The idea is that the chain can be pulled endwise and the channel, which otherwise would clog up, can be kept clear. Many a time some fellow has driven some of the plank fastening through a link of the chain and there has been some tall swearing when it was found that it could not be moved.

"In the steel ship the limber chain has been abandoned and only the limber hole or drain remains. These holes are cut down against the toe of the bar and are of 3-inch or 2½-inch diameter. They are also cut in other places to give ventilation in the inner bottom through floors, longitudinals, etc. The inner bottom has to be painted. Sometimes it has to be enameled with bitumastic, and then ventilation is very important. In addition, air vent holes about 1-inch diameter are often punched in the bosom of the upper bars. These holes prevent air pockets in compartments that are to be flooded and permit the escape of air or gas to vents or sounding tubes in oil tanks, etc.

"Holes 1 inch diameter by 2 inches long or ¾ inch by 1½ inches may be cut in the bosom of the lower angles. They are cut by punching three holes in a line and allow good drainage to a suction at the lowest point.

"By the way, do you know how close to the heel of a bar the yard can punch? Well, here is a sketch that I got out for Big Riley the other day. He wanted some new dies for his angle punch. You see the hardened die fits in a hole in an under part that is cut away at the side. There are two sizes. One takes dies for ¼-inch, 5/16-inch and ⅜-inch rivets, and the distance from the edge to the center of the hole is 9/16 inch. The other size takes ½-inch, ⅝-inch, ¾-inch, ⅞-inch and 1-inch and the hole center is an inch from the edge. So that 9/16-inch or 1 inch added to the thickness of the bar gives the minimum gage. Of course, you can drill holes closer than this, in which case the edge of the hole is flush, or a little closer to the flange.

"The webs of channels, eyebeams, etc., are sometimes lightened by cutting out round or oblong holes. This is done on light high speed work where weight is very important. Here also bracket flanges are tapered, angle corners are snipped off and butt and seam straps are scalloped on the edges.

"I suppose you remember that that gas man claimed that holes through plate can be burnt out for about 2½ or 3 cents per linear foot."

Mac was interrupted by the whistle. Red did not find out until the next day what had become of his spare limber hole nor how Old Mac had taken the burden of his little joke.

Water Sprinkling System on Vessels.—Recent rulings by the Board of Supervising Inspectors of the United States Steamboat Inspection Service require an efficient overhead water sprinkling system installed over the main deck freight space on all steamers carrying passengers, and which also carry freight on the main deck, which is accessible to passengers and crew while being navigated.

Mast, Boom and Rigging Design

Analytical and Graphical Methods of Obtaining Stresses in Rigging—Safe Loads—Structural Details

BY F. K. RUPRECHT

THE design of masts and booms and their rigging is a problem often met with in naval architecture and in the drafting rooms of every shipyard. To the writer's knowledge no attempt has ever been made to explain the methods used, and it is hoped that this article will be a help to those called upon to prepare designs without having had previous experience.

Fortunately steel masts are designed with a large factor of safety, and so the little attention paid to this subject has not proved fatal. The object of going into the subject a little further is to be assured that all parts are of fairly uniform strength, thereby avoiding excessive weight, cost and unrational design.

The starting point is the design of the mast. This member is subjected to compression and bending due to the pull in the topping lift and to the thrust of the booms connected to the mast and finally to the reaction of the supports.

The forces which would cause bending due to the pull in the topping lift are taken in the fore and aft and side stays. This leaves only compression to be taken by the mast. The reaction of the booms, if connected to the mast, is resolved into compression, but leaves an unbalanced side thrust which causes bending and shearing in the mast. Its moment is small because, as a rule, the boom connection is not far above the deck and the hollow circular section of the mast is well able to take care of this bending when strong enough to carry the compression. The forces at the supports are pure shear, and bending, but the moment is small. At the upper deck we have shearing and likewise at the lowest support.

In a great many cases the boom tables are entirely free from the mast and so the extra compression due to the boom reaction is not considered on the mast, nor is it necessary to make any provision for boom side thrust.

Methods of Obtaining Stresses

Turning now to the methods of obtaining the stresses in the mast, boom and rigging, and the required strength of these members, we find two ways of attacking the problem; one is the analytical method of forces and angles and the second is the graphical. The latter is quicker and gives results that are easily accurate enough to all intents and purposes.

The starting point is the weight that the mast is to carry. We assume the weight is suspended from the end of the boom and that the mast, boom and shrouds are in equilibrium. Then the forces that hold the weight in equilibrium are the thrust along the boom and the pull in the topping lift and side stays. This pull in the topping lift is a maximum and the thrust in the boom is a minimum when the boom is at right angles to the mast. When the boom is parallel to the mast or as nearly so as the construction will allow, the pull in the topping lift is a minimum while the thrust in the boom is equal to the weight lifted. In most cases of ships' booms the angle between mast and boom is seldom 90 degrees, but the stress in the topping lift must be figured for the maximum angle; that is, when a weight is being raised from the most distant part of the hatch. Likewise the compression in the boom must be taken when a weight is being raised from the nearest edge of the hatch. Sometimes the boom will have to be turned to a greater angle in order to land the load in a lighter or onto a pier alongside, and the boom may be required to raise a weight nearly alongside the mast. If the latter cases are at all liable to occur the stresses in this condition must be taken when figuring dimensions and in the case of general cargo boats it would seem best to assume both the maximum conditions as necessary ones.

Pull in Topping Lift

The pull in the topping lift is resolved into compression on the mast and tension in one of the side, bow or horizontal stays. The more acute the angle between stay and mast, the greater the tension in the shroud, so that in the ordinary case, if we figure compression considering the boom and weight swung to one side of the ship since the rigging on the opposite side carries the entire tension, we get a maximum condition. In some cases, however, the bow or stern stay makes the sharpest angle with the mast, in which case this condition would be figured. All three cases—that is, bow or stern stay, side stay and fore and aft horizontal stay—must be figured when getting out the dimensions for the standing rigging and the maximum condition assumed for each case.

Having obtained the compression in the mast due to one boom, we must multiply by the number of booms which will be used at the same time. This will give the total compressive force on the mast. This, in the case of an independent boom table, gives the compression that acts between the top of the mast and the bottom support. In the case where the boom table is part of the mast, this compressive force is the one that acts between the top of the mast and the boom table. Between the latter and the bottom support the compression is the sum of that due to the topping lifts and to the thrust in the booms.

The effect of the pull in the haul of the winch must now be considered. The amount of this pull depends upon the tackle. In a great many cases a direct lead is used with a block at the end of the boom only, for this gives greater speed in discharging a general cargo composed of comparatively moderate weights. Sometimes a single block is fitted at the boom and one at the cargo hook with the standing connection at the upper block.

Again, two double blocks may be used or a single block at the weight with standing connection, and a double block on the boom, and only when weights are exceptional is more tackle than this required.

After the arrangement of the tackle has been agreed upon the pull in the haul is obtained by taking $P = \frac{W}{n}$

where P is pull in pounds, W the weight raised in pounds, and n the advantage of the tackle, which is equal to the number of running and standing connections between the blocks—that is, in the first case mentioned $n = 1$, in the second case $n = 2$, in the third case $n = 3$ and in the

fourth case $n = 4$. The pull P is added to the weight raised W, and $P + W$ is the actual force acting on the connection at the end of the boom and is the one used in design.

As a rule the lead to the winch is made by means of a block fastened to the deck plating, but even if this block is connected to the mast the additional stresses are in most cases very small. The sudden strains due to sudden raising of the weight or of the boom on the standing rigging and spars themselves should be considered in fixing upon the safety factor.

The topping lift is usually arranged to allow the boom to be lowered and raised as desired when discharging or taking on cargo. This rigging in most cases is a single block at the mast with a standing connection on the boom, or a single block at boom and mast in the case of heavy steel booms. In general cargo boats the topping lift is often a chain and the angle between mast and boom remains constant. The chain is adjustable so this angle can be varied to suit any special port or lighter conditions.

The pull P, due to raising weight and boom, at once increases the compression on the mast and the tension in the standing rigging. The weight is here w^1, and is composed of W, the weight raised, and one-half the weight of the boom Y, so that $P^1 = \frac{Y}{n}$ where P^1 is pull in topping lift due to raising boom and n is as above. Then the total pull is $P + P^1$.

The weight of the boom must be considered in the actual case, since it materially increases the tension in the topping lift and the compression in the mast.

Table 1.—Breaking Strength of Manila and Hemp Rope.

Circumference.	Diameter.	Manila Breaking Strength.	Hemp.
Inches.	Inches	Pounds	Pounds
¾	¼	585	1,008
1	5-16	700	1,344
1⅛	⅜	900	......
1¼	7-16	1,170	1,680
1½	½	1,800	2,352
1¾	9-16	2,295	3,136
2	⅝	3,200	4,144
2¼	¾	3,750	5,162
2½	13-16	4,050	6,496
2¾	⅞	6,050	7,800
3	1	7,200	9,408
3¼	1 1-16	7,875	11,000
3½	1⅛	9,800	12,544
3¾	1 3-16	10,500	......
4	1¼	11,250	16,240
4¼	1⅜	13,500	......
4½	1 7-16	14,450	20,720
4¾	1½	16,200	......
5	1⅝	20,000	25,760
5½	1¾	23,650	......
6	1⅞	27,000	36,960

Strength of Tarred Hemp is same as Manila.
Hemp quickly rots when exposed to elements and therefore should be tarred.

Pull in Standing Rigging

The pull in the standing rigging is found at the same time as the compression in the mast as outlined above. Knowing the pull in the latter and using a factor of safety of six, the sizes and number required can be taken from the annexed tables of strength of Manila and hemp rope and wire cable.

The rope for raising the weight may be wire, Manila or hemp, depending on the tackle. If a direct pull is decided upon, wire rope is usually used. When double blocks are used rope is strong enough and is easier to reave through the blocks. The sizes may be taken from the tables. On ships carrying heavy cases we find special blocks at the boom end and on the mast to take care of these great weights and in these cases wire rope is used throughout. The strength of the tackle is often determined by the strength of the block rather than the rope, so care must be used to be sure to consider both factors in fixing upon the safe load.

Standard blocks of wood or iron as manufactured are

TABLE 2—BREAKING STRENGTH OF IRON AND STEEL ROPE

Cir-ference.	Diameter.	Strength, Best Galvanized Iron.	Strength, Galvanized Mild Steel.	Strength, Swedish Iron Hoisting Rope	Strength, Cast Steel Hoisting Rope	Strength Flexible Steel Wire Rope for Cargo Falls in Tons, 2,000 H		
						Flexible	Special Flexible	Extra Special Flexible
Inches	Inches	In Tons 2000 H	In Tons 2000 H	In Tons 2000 H	In Tons 2000 H			
¾	¼	....	....	1.1	2.2	....	....	....
1	5-16	1.2	1.75	1.5	3.1	2.1	2.79	2.57
1⅛	....	1.5	2.25	2.4	4.8	....	....	....
1¼	....	1.87	3.0	2.9	6.5	3.28	4.34	4.03
1⅜	....	2.25	3.25	....	....	....	....	....
1½	....	2.62	4.0	3.9	8.4	4.74	6.2	5.89
1⅝	....	3.12	5.0	....	....	....	....	....
1¾	....	3.62	5.5	4.7	10.0	6.47	8.37	7.75
1⅞	....	4.12	6.0	....	....	....	....	....
2	....	4.7	7.0	6.0	12.5	8.37	11.16	10.54
2⅛	....	5.3	8.0	....	....	....	....	....
2¼	....	6.0	9.0	8.5	17.5	10.54	13.95	13.02
2¾	....	6.6	10.0	....	....	....	....	....
2½	....	7.3	11.0	....	....	13.62	17.36	16.12
2⅝	....	8.2	12.0	....	....	....	....	....
2¾	....	8.8	13.0	11.8	23.0	15.81	21.08	19.53
2⅞	....	9.7	14.5	....	....	....	....	....
3	....	10.6	16.0	14.5	30.0	18.91	25.11	23.25
3⅛	....	11.5	17.5	....	....	....	....	....
3¼	....	12.3	19.0	....	....	22.32	29.45	27.28
3⅜	....	13.3	20.5	....	....	....	....	....
3½	....	14.3	22.0	18.6	38.0	25.73	34.1	31.62
3⅝	....	15.3	24.0	....	....	....	....	....
3¾	....	16.5	26.0	....	....	29.45	39.06	36.27
3⅞	....	17.6	28.0	....	....	....	....	....
4	....	18.7	30.0	22.8	47.0	33.79	44.64	41.23
4⅛	....	20.0	32.0	....	....	....	....	....
4¼	....	21.2	34.0	28.0	56.0	37.82	50.42	46.81
4⅜	....	22.5	36.0	....	....	....	....	....
4½	....	23.7	38.0	....	....	42.47	56.42	52.39
4⅝	....	25.1	40.0	....	....	....	....	....
4¾	....	26.5	42.0	33.0	64.0	47.43	62.93	58.28
4⅞	....	28.0	44.0	....	....	....	....	....
5	....	29.3	48.0	38.0	72.0	52.39	69.75	64.48

For Standing Rigging the safety factor may be taken as 4 or 5.
For Running Rigging the safety factor may be taken as 6.

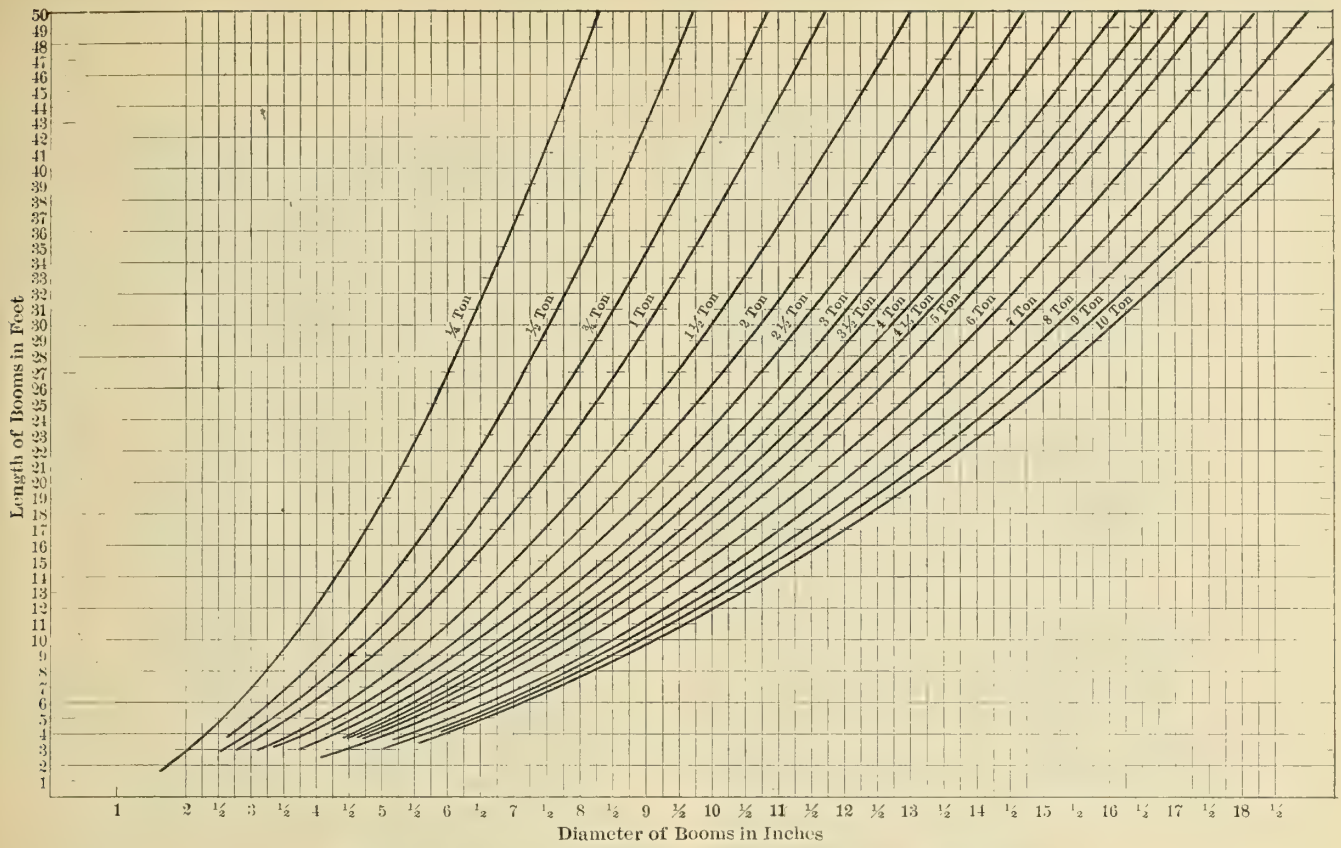


Diagram for Wooden Cargo Booms (1 Ton = 1,000 Kg. = 2,205 Lbs.)

The curves can only be applied to booms made of fir or wood equivalent in strength. For booms of pitch pine, divide result of diagram by 1.11 to obtain diameter. Diameter at ends = .77 D. $D^2 = 0.3\,L\sqrt{\frac{W}{E}}$; with W in kg.; L in meters; D in cm.; E = modulus of elasticity.

designed for a given working load. These blocks are usually satisfactory, but there are cases where it is desired to use a smaller block for a given load than the commercial type. In this case the sheaves, pins, etc., must be designed to carry the load with a factor of safety of six. The question of wood or iron blocks is an open one. Wood below a 14-inch block makes a satisfactory ruling, and iron above, except where only single leads are used, when iron blocks for all sizes above 8-inch give best service. The standard blocks for raising a given load are designed for that load with a factor of safety of about six and the sheaves are made to fit the size rope that will be required. The pins are figured for shear, and this gives ample strength against bending.

Steel masts are designed as columns and are usually of circular section built up of plates stiffened by angles on the inside. When under 24 inches diameter they are built up of two strakes of plating, and when above of three strakes. The minimum diameter is not fixed by the consideration of strength, but by the practical problem of building them. About 14 inches seems the smallest possible diameter for mast or boom and 10-pound plating about the lightest that should be used. The ends of the booms will be about two-thirds the largest diameter. The top of the mast may be made smaller than two-thirds the largest diameter, if practical, but the bottom should be a full two-thirds.

The stiffeners are generally angles, three or four in number. Some yards arrange stiffeners on the plating seams and other yards between the seams. The seams and laps may be lapped or strapped, but in high class work they are generally fitted with angle edge and buttstraps.

Wooden top masts are generally used, since strains on these are small and it would be uneconomical to build them of steel when a light wood spar will suit the purpose. Steel, unless of built-up sections, could not be made small enough because of practical reasons.

Wooden booms are used on all kinds of ships, but should not be used for loads over about eight tons. Annexed is a set of curves for wooden booms the correctness of which has been proved in practice.

Steel masts or booms can to advantage be built up of latticed channel columns or in heavy masts of plate and channel columns. A considerable saving of weight would be effected and the cost would be less. The deterioration on an open steel structure of this kind would be less than that of a hollow steel boom or mast. Booms may also be designed as columns in the same manner as masts.

In fixing upon the dimensions of masts or booms, it is suggested that Johnson's straight line formula be used, which is

$$P = S - K\frac{L}{V}$$

P = Ultimate strength,	Values
S = Maximum tensile unit stress,	= 52,500
K = A constant,	= 3,400
L = Length of mast or boom in feet,	
V = Least radius of gyration.	

A factor of safety of at least six should be used. Where especially hard usage is expected under bad conditions, eight could reasonably be used.

In figuring the radius of gyration, a shell of uniform thickness may be assumed and no account taken of edge laps or straps. The vertical stiffeners are, of course, to be included in figuring the radius of gyration (V).

V for ring is $\frac{1}{4}\sqrt{(D^2 + d^2)}$

Where D is outside diameter and d is inside diameter.

(*Concluded on page* 114)

IN THE SHOPS OF THE NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY

(Photographs by Press Illustrating Service, Inc., New York)

Fig. 1.—Cutting Openings in Ship Plates

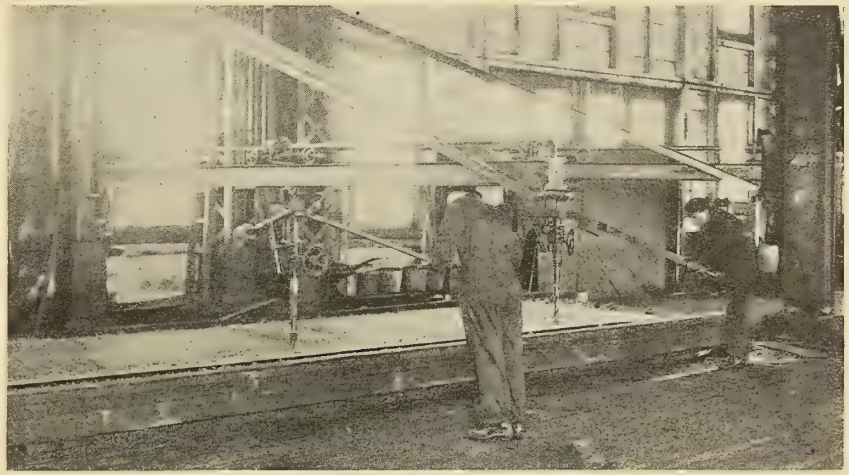


Fig. 2.—Reaming and Countersinking Rivet Holes in Ship Plating

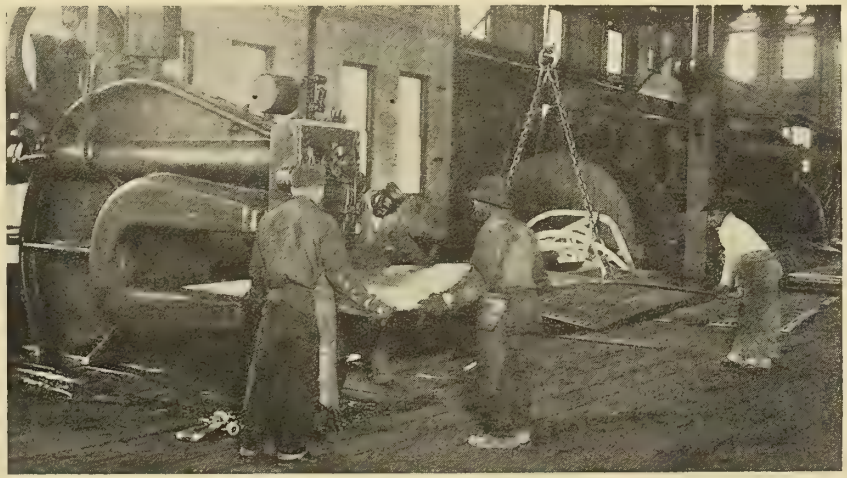


Fig. 3.—Punching ¾-Inch Steel Plate

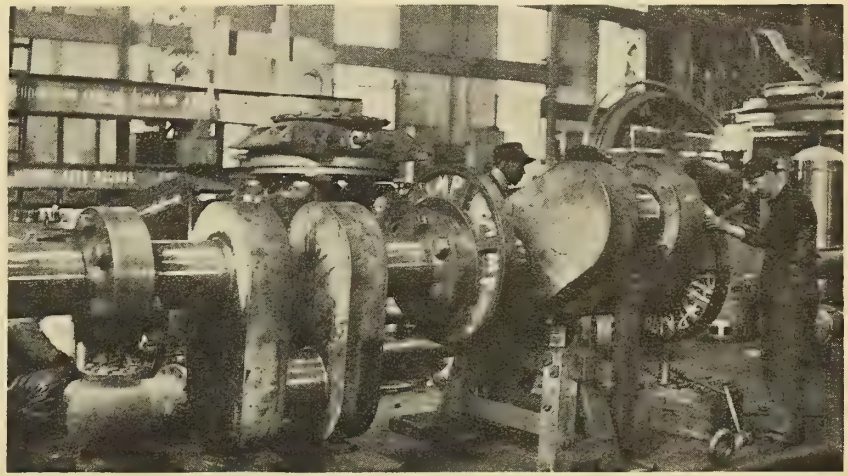


Fig. 4.—Finishing Engine Crank Shaft

Work at the Newport News Yard

Newport News Shipbuilding & Dry Dock Company Executing Contracts for Nearly 200,000 Tons of Shipping

THE Newport News Shipbuilding and Dry Dock Company, Newport News, Va., which but recently launched the superdreadnought *Mississippi,* is having a record-breaking experience in shipbuilding. There is more work in the yard and more under contract than ever before in the company's history. The number of merchant ships under contract is twelve; the number of battleships three. The gross tonnage of the merchant ships is 86,375; of the battleships, 96,000. The number of ships delivered in 1915 was five, and the aggregate value of work on hand in that year was $30,000,000 (£6,150,000). The number of ships delivered in 1916 was eight, including the battleship *Pennsylvania,* and the value of work on hand at the end of 1916 was more than $50,000,000 (£10,250,000).

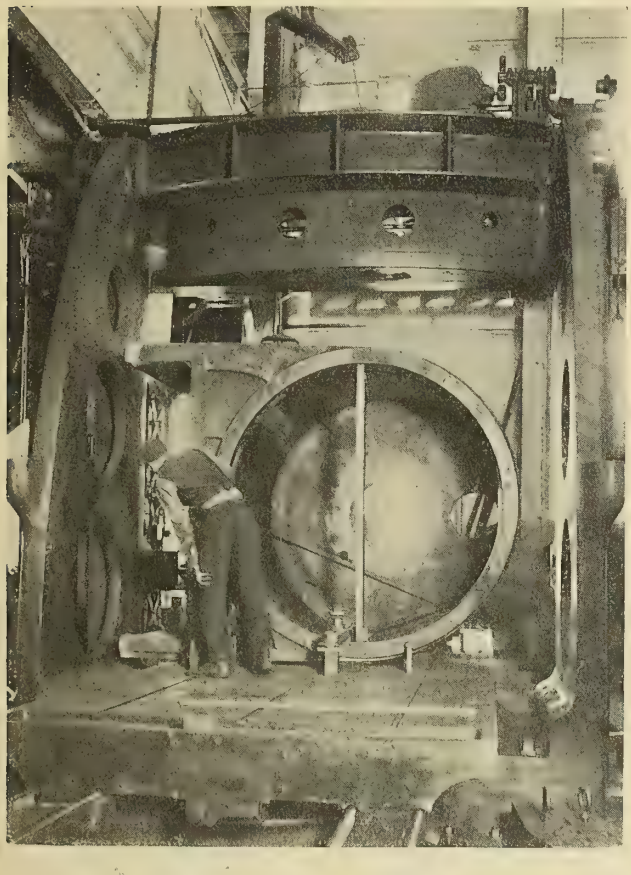


Fig. 5.—Planing an Engine Cylinder Casting

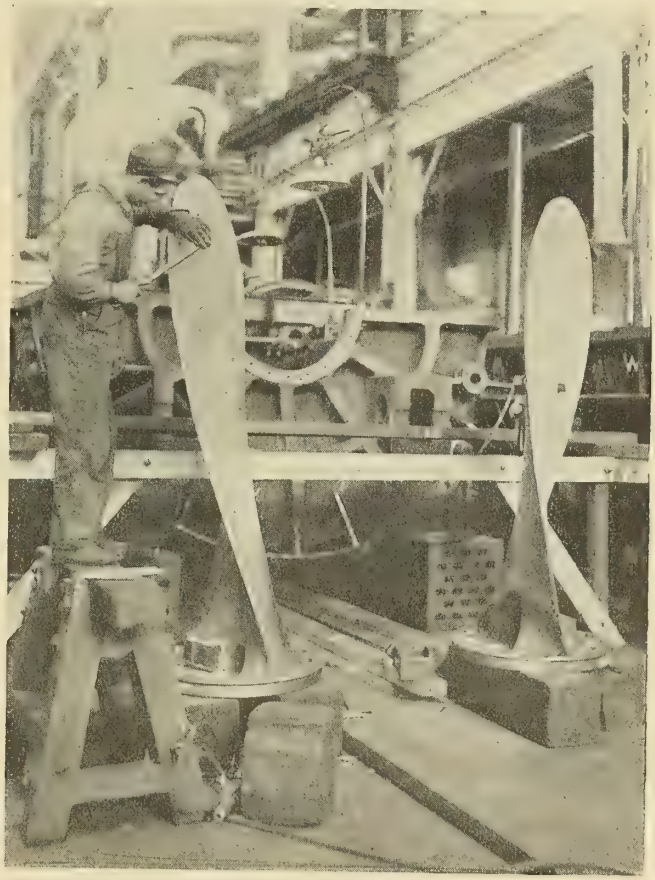


Fig. 6.—Finishing Face of Propeller Blade

The number of men now on the payroll is approximately 7,000, and the amount of wages paid out is over $100,000 (£20,500) per week. The work now on hand is as follows:

H. M. Flagler, oil carrier, 8,375 tons, Standard Oil Company.

W. G. Warden, oil carrier, 11,000 tons, Standard Oil Company. (just completed).

F. Q. Barstow, oil carrier, 11,000 tons, Standard Oil Company.

O. B. Jennings, oil carrier, 11,000 tons, Standard Oil Company.

J. C. Donnell, oil carrier, 11,000 tons, Atlantic Refining Company.

Felix Taussig, merchant ship, 6,000 tons, Crowell & Thurlow Steamship Company.

No. 200 (not named), merchant ship, 4,600 tons, Munson Line.

No. 206 (not named), merchant ship, 4,600 tons, Munson Line.

No. 207 (not named), merchant ship, 4,600 tons, Munson Line.

Torres, merchant ship, 5,200 tons, Southern Pacific Company.

El Almirante, merchant ship, 4,500 tons, Southern Pacific Company.

El Capitan, merchant ship, 4,500 tons, Southern Pacific Company.

Mississippi, battleship, 32,000 tons, United States Navy.

West Virginia, battleship, 32,000 tons, United States Navy.

Maryland battleship, 32,000 tons, United States Navy.

Notwithstanding the large amount of work on hand, the company is able to do its part of the Government construction and stands ready to build one or more of the battle cruisers, having already submitted its proposals to the Secretary of the Navy.

The past year was notable also in the number of contracts turned away. It has ever been the policy of the company to give preference to Government work over private work and to American work over work for foreign

shipping lines. In 1916 the company turned away twenty-six proposals from foreign concerns that it might reserve its facilities for American lines; and after April 1 it declined to make any new contracts even with American lines, in order that it might be in position to do its fair share of naval construction.

The president of the company, Homer L. Ferguson, recently stated before the House Naval Committee that his company would have put its works in condition to build the battle cruisers as soon as ordered had the Department of the Navy been friendly, "in a business way," to the

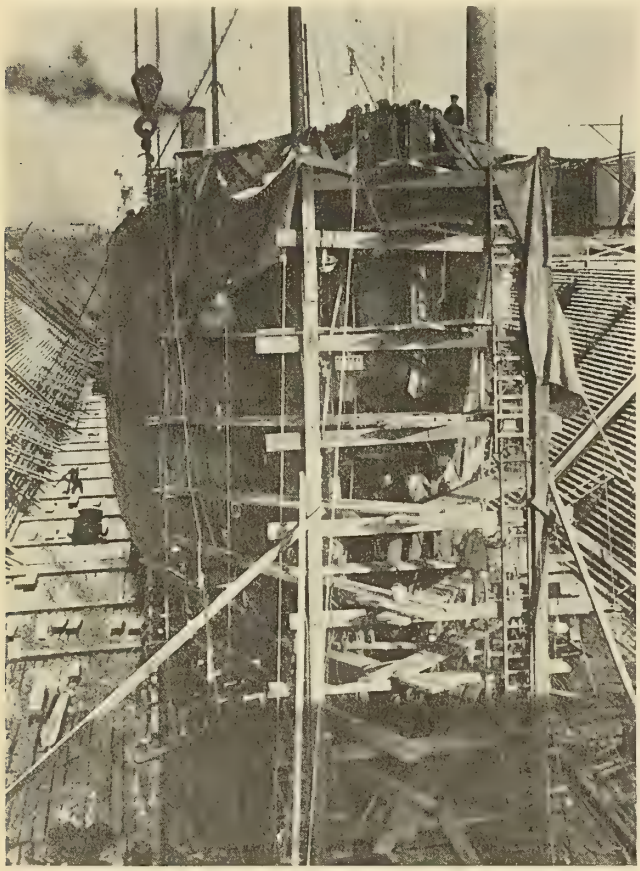


Fig. 7.—Repairs to Damaged Bow of Steamship in Dry Dock

private shipyards. But the policy of the Secretary of the Navy seemed to be to build as many as possible of the Government's ships of war in navy yards, and as private shipbuilders had no guarantee that they would secure contracts from the Government it was only human and only ordinary business foresight and prudence that they should take on a liberal supply of private work when opportunity offered. It is well known in shipbuilding circles that Government contracts, especially battleship construction, are very desirable in every large shipbuilding plant.

The Newport News company is prepared to begin work at an early date on the new battleships, and if the contract is awarded to build one of the battle cruisers, the work of building a new shipway will begin immediately and be pushed to a speedy conclusion.

In order to take care of its new construction the company will expend at least $750,000 (£153,800) this year in additional equipment, and if the contract for the battle cruiser is secured, the outlay will double that sum.

One of the most notable improvements of the past year was a first-aid dispensary, which is said to be the "last word" in that type of building. It is provided with every possible device of modern medical and surgical science and has a full corps of surgeons and trained nurses. The institution is maintained entirely at the expense of the company and employees who are injured or taken suddenly ill in the service are treated free. The purpose of the dispensary is to reduce the evil effects of an injury to its lowest terms by giving the victim prompt treatment, and, hence, to restore him in the shortest possible time to usefulness and efficiency.

During the year the company unveiled near the dispensary and just back of the main office building, where it is in constant view, a granite memorial to the founder of the yard, Collis Porter Huntington. The memorial stone carries a bronze tablet upon which is written this inscription:

"We will build good ships here, at a profit if we can, at a loss if we must; but always good ships."

That was the motto which Mr. Huntington himself adopted for the company, and it is the motto of the company to-day. The company has never built a ship that was not creditable to the builder and profitable to the operator. The last ship to be completed is the *William G. Warden*, which has just had her trial trip. It is one of seven which the Newport News company has built for the Standard Oil Company.

Among the new improvements contemplated during the

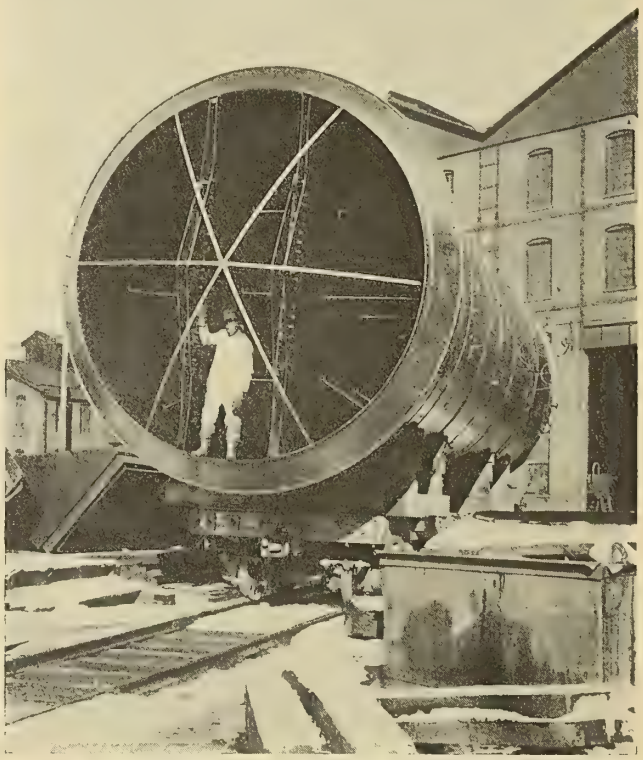


Fig. 8.—Steamship Funnel, 18 Feet Diameter by 45 Feet High

present year is a new administrative building, but plans for that have not yet been completed. The expenditures made during 1916 for improvements cover principally the installation of equipment necessary to keep the plant in an up-to-date condition. A north and south craneway was installed to provide more efficient distribution of material from the shops to the various shipways. Extensive replacements were made in the power house; several small buildings, such as tool rooms, etc., were erected, and a number of new machines were installed in the machine shop. The use of oxy-acetylene and electric welding has been considerably extended throughout the yard.

Development of American Oil Tankers

Early Sailing Vessels Fitted as Oil Carriers—Advent of Steam Oil Tankers — Adoption of Fuel Oil

BY J. H. MORRISON*

AMERICAN petroleum was first transported to foreign countries in about 1864. At this time and for several years later the oil was contained in barrels; but in the eighties tin cans encased in wood were used for the Eastern trade. Even with the best workmanship the loss by leakage in this method of carrying the oil was so great as to be a serious danger to the vessel as well as a large loss to the owner of the oil.

Russian oil had been produced at a much earlier date than American oil, but its transportation to any distance had been limited to the Caspian Sea and the Baltic Sea by small vessels on the Volga River, at a later date. Not until a railroad was constructed connecting the Black Sea and Caspian Sea from the Baku oil fields, about 1882 and an embargo on the export of the oil was removed by the Russian Government did Russian oil find the way to the Mediterranean Sea for export.

The vessels carrying our oil to Europe for several years were almost wholly sailing vessels, and in many cases of a low rating, for owners of vessels at this time would refuse a cargo of oil on account of the nature of the cargo itself, as well as the difficulty of eradicating the smell of the oil, thus making the vessel unfitted for the carriage of a general cargo after the discharge of the oil. The character of the vessels used may be further seen from the following statement made in April, 1882, by one of our marine journals regarding the losses of vessels in oil transportation in the North Atlantic Ocean:

Loss of Early Sailing Vessels Carrying Oil

"It is stated that no less than fifty-eight sailing vessels, with cargoes of refined petroleum, have been lost within the past four months, the last one reported as missing being the Norwegian bark *Matador,* formerly the American bark *Aramingo,* built in New York in 1851, sailing from here on October 1, 1881, with a cargo of 223,027 gallons of petroleum for Bremen. She was in command of Captain Frederickssen and had a crew of fourteen men. Since that time she has not been heard from and has been given up for lost. She was of 685 tons burden, double decked, valued at about $12,000 (£2,500) and was fully insured in England. The owners were E. Salvonson & Co., of Mandel, Norway. This terrible loss rate, one every two days, is quite equal to those of Canadian grain-laden and British coal-laden vessels, which occurred a few years ago and which caused official inquiry in Great Britain at that time. * * * Possibly it is due in some degree to the poor class of vessels that petroleum is generally shipped in. * * * Vessels engaged in the transportation of refined petroleum to the East Indies do not fare as badly in this respect as vessels carrying crude petroleum in the Atlantic trade. Why is this?"

The loss of so many vessels in the same trade and carrying the same class of merchandise over the same route prompts an inquiry as to the weather conditions of the North Atlantic during the period from October, 1881, to April, 1882. We find the ice season of 1881 was another very light ice season. During the summer and fall there were no obstructions along the usual steamer routes from ice, but many steamers reported thick fog during almost the whole passage. The ice season of 1882 opened early in February with heavy ice to the eastward of the Grand Banks and in March many icebergs were seen as far south as latitude 42 degrees 30 minutes and longitude 50 degrees west. This was one of the years when very heavy ice and icebergs were found in the North Atlantic Ocean.

The class of vessel, with the inflammable nature of the cargo and the want of experience in handling such merchandise at sea, no doubt was the cause of the loss of many vessels. With the coming of the steam tanker a few years later, improvements were made in the transportation of oil at sea.

A few English sailing vessels were fitted to carry oil in bulk on the North Atlantic about 1870 or 1875, but little has been handed down regarding them, further than that they were not successful as oil carriers.

The division of the hold of a vessel for storage of the cargo is on the principle of the division of the hold of the trading vessels of the Chinese more than a century ago, as well as the division of the interior of steam vessels of later years into watertight compartments.

The First Steam Bulk Oil Carrier

The first steam vessel built for the purpose of transporting oil in bulk was the *Vaterland,* of 2,800 tons, constructed in 1872 by the Palmer Shipbuilding Company at Jarrow-on-the-Tyne, for the Red Star Line, that had just been organized, mostly by American capital for operation under the Belgian flag between Antwerp, Belgium, and Philadelphia, Pa. This vessel was 319 feet by 38 feet 6 inches by 23 feet, having two decks and a spar deck, and was constructed with a double skin, having a space of about 22 inches between the inner and outer plating, the inner skin being calked perfectly tight. The lower hold was divided into compartments by six athwartship bulkheads for a length of about 170 feet and again subdivided by a fore and aft bulkhead on the centerline. All of these bulkheads were carried to the underside of the deck, and the latter was made double with a space of about 8 inches. Precautions were taken for an overflow of the oil under an increase of temperature. The motive power was a compound engine located in the afterpart of the vessel, as in most of our oil tankers.

Two more vessels were built for the same line and purpose by the same builders—the *Nederland* in 1873, and the *Switzerland* in 1874. These latter vessels had their machinery in the center of the length, or nearly so, of the vessel. It has been claimed that these vessels carried passengers, and at the same time oil in bulk as cargo, for a few voyages only, but this is an error. The manifest of the *Vaterland,* leaving on her first voyage from Philadelphia on February 26, 1873, shows that she "carried a general cargo, which did not include any oil." Besides, the writer has it from an authority on the subject, who says, "those vessels were designed for carrying oil in bulk, but never did so."

* Author of "History of American Steam Navigation."

There was much agitation in 1872, and later in Great Britain, on the great losses of cargo vessels in the North Atlantic, and that resulted in the Plimsoll load waterline measure. At the same time, in this country, there was a revision being made of our steamboat inspection laws, that greatly affected the carrying of inflammable articles on passenger steamers. Freight rates also on the North Atlantic were now at high figures, and sailing vessels in that trade being out of date, it is more than probable that some of these conditions changed the carrying of bulk oil on steamers to a later date.

It was not on the North Atlantic Ocean, but on the Caspian Sea, that the carriage of oil in bulk in a steam vessel was first brought into use. The scarcity of wood and the consequent large cost of barrels as packages for containing the oil, compared with the value of the oil they contained, forced the experiment of the transportation of the oil in bulk on the Caspian Sea to the Volga River in 1879 in small vessels of from 300 to 400 tons each.

English Steamer Converted to Oil Tanker

The first steam oil tanker, other than Russian, was the *Fergusons* (formerly the *Calliope Nicolopulo*), built in 1880 in England, of 1,551 tons, 250 feet by 34 feet 5 inches by 18 feet 8 inches, and converted into a tanker in 1886. This vessel had iron tanks fitted in the hold and between decks. She was destroyed by fire a short time after being altered. Some of the vessels originally constructed for oil tankers were the *Era*, of 1,851 tons, 271 feet by 37 feet by 15 feet, built at Newcastle; *Broadmayne*, of 3,095 tons, built in 1888 by the same builder as that of the *Era*, and the *Wildflower*, built in 1889, of 2,657 tons, 310 feet by 40 feet by 28 feet, and having six oil tanks—all English-built vessels.

A tank vessel was built in the United States for transporting molasses in bulk at about the same period as a few early oil tankers (reconstructed sailing vessels) were placed in service in Europe. This tanker was the brig *Novelty*, built by the Atlantic Steam Engine Works, of East Boston, Mass., in 1869, for Nash, Spaulding & Co., of Boston, and others for the carriage of molasses in bulk from the West Indies. The vessel was 128 feet by 27 feet by 12 feet. The hold of the vessel was divided into seven compartments for the storage of the cargo and had a capacity for 88,000 gallons. The vessel sailed on her first voyage for Matanzas, Cuba, on May 20, 1869. It was claimed that the vessel was a success. The vessel sprang a leak while on a voyage from Boston to Cardenas on April 1, 1874, in latitude 38 degrees 55 minutes and longitude 73 degrees 3 minutes, and sank the next day. It is thought the vessel was chemically weakened by the nature of the cargo.

The Standard Oil Company's First Tanker

The Standard Oil Company, of New York, was not far behind the English oil transportation companies in the building of a steam oil tanker. Their pioneer vessel was the *Maverick*, built by the Columbia Iron Works and Dry Dock Company, at Baltimore, Md., in 1890. The hull of the vessel was of open-hearth steel, the dimensions being 239 feet 9 inches by 36 feet by 24 feet 8 inches, the motive power being a triple-expansion engine, having cylinders 19 inches, 30 inches and 50 inches diameter, with a stroke of 36 inches, placed well aft in the vessel.

The vessel was launched on January 25 and sailed from Baltimore for New York on May 18, 1890, where she arrived the next day under command of Capt. William Evans. The vessel was built for the transportation of refined oil between Philadelphia and New England ports and had a capacity for 500,000 gallons of oil. This service was performed by the vessel until July 17, 1899, when she was almost wholly destroyed by fire while in Bedford Basin, an arm of Halifax harbor, Nova Scotia.

While engaged in pumping her cargo of oil into the tanks of the Imperial Oil Company the 6-inch supply main burst and the oil flooded the engine room and fire room, and caught fire. The flames soon enveloped the whole vessel, and the heat became so intense that the crew were forced to desert the vessel. There were several hundred cases of oil on board that caused explosion after explosion. The vessel sank at the dock. She had in tow two barges with a cargo of oil in barrels.

The vessel was subsequently raised, but it was a more difficult task than was at first anticipated. It was not until June 26, 1900, almost a year, before the vessel arrived at the Bath Iron Works, Bath, Me., where she was rebuilt and completed for service in the following November.

The vessel remained on the Atlantic coast until January 14, 1907, when she was sent to San Francisco with barge *No.* 91, having also a cargo of oil. She was 81 days on the voyage without a stop at any port. This was another instance of a long voyage by a steamer—about 14,000 miles—and no stop for fuel was made necessary when burning coal under the boilers. The vessel is still in service on the Pacific coast.

The Maverick Followed by the Atlas

The *Maverick* was the only oil tanker built in this country and in service until the Standard Oil Company had the *Atlas* constructed by the Delaware River Iron Shipbuilding and Engine Works (John Roach & Son), at Chester, Pa. This vessel is about 400 tons larger than the *Maverick*. The hull is divided into watertight compartments, twelve of which are used for oil tanks, having a capacity of 720,000 gallons of oil. When built the vessel had a complete electric light plant. The motive power is a triple-expansion engine, located nearer the center of the length of the vessel than in the *Maverick*. She was placed in service in January, 1899, running to North Atlantic ports, about six months before the *Maverick* was burned. The vessel was loaded with 600,000 gallons of oil on December 15, 1904, and with barge *No.* 95, also having a cargo of oil, in tow, was sent to San Francisco, Cal., where she arrived in 72 days from New York. The vessel has since remained on the Pacific coast.

In 1904 the Standard Oil Company had constructed at Shooters Island, New York, two of their largest tank barges, or schooners, *Nos.* 94 and 95. The hull and masts of these vessels are of steel, and the hull dimensions are 360 feet 5 inches by 50 feet by 27 feet, divided into twenty compartments, five of which are for water, one for fuel, one for the pumping engines, and the remainder of the compartments for a cargo of oil. The boiler furnaces were built for using either oil or coal. The vessels were fitted each with five masts, the foremast being used as a funnel for the boiler room. The engines do all the pumping of the oil and housing of the sails. On the spanker-mast leading to the stern is the rigging of a wireless system which connects with an apartment in the stern of the vessel. The officers' quarters are in the stern of the vessel and are very nicely furnished. One of these vessels, *No.* 95, was sent to the Pacific Ocean in tow of the tanker *Atlas* in 1905.

The Anglo-American Oil Company, one of the large oil transportation companies of Great Britain, in which the Standard Oil Company, of New York was and probably is now interested, was organized in 1901 of a combination of interests for the transportation of petroleum oil.

There were fourteen steam oil tankers that had been constructed in Great Britain prior to 1895, and not exceeding 3,500 gross tons each, most of these vessels being built at Newcastle.

The finest vessels of the new company at this period were the *Tuscarora,* built in 1898, of 6,117 gross tons, and the *Narragansett,* built in 1903, of 9,196 gross tons, the latter being 512 feet by 63 feet 4 inches by 32 feet 8 inches. At the time of her construction this vessel was considered as the last word in the building of that type of vessel. The oil tanks are all below the main deck, and are sixteen in number, eight forward and eight aft of the machinery space. Between the main and upper decks are four smaller oil compartments. The oil capacity of the vessel is 73,500 barrels. The motive power in both of these vessels is located amidships. Both of these vessels have been frequent traders to the United States.

The Deutsch-American Petroleum Company (German-American), in which the Standard Oil Company has been interested, was organized about 1890. Most of their vessels were built in Great Britain, though a few were constructed in Germany. Several of their vessels may now be found under American register for the Standard Oil Company.

Experiments in Burning Fuel Oil

The development of the steam oil tanker in this country dates from the building of the *Atlas,* in 1899, as a mate to the *Maverick.* At this time the "gusher" wells of Texas had not shown their power for producing crude oil in such quantities as they did in the early part of 1901. It was just prior to this that our engineers had begun experiments on improved methods of burning the oil; so the improved methods and the increased supply of fuel oil came at a time when they were needed.

The Texas oil and the California oil were found to give a larger percentage of fuel oil under refining processes than any oil thus far brought under experiment. There was another advantage for the consumer, that the oil wells in the Texas and California fields were located so near tidewater that it required but short pipe lines to bring the oil to market for marine and other purposes.

Most of the oil on the Atlantic coast was transported by rail until the tankers were built, for some of the railroads, as well as the manufacturers, were experimenting to see if there was any saving by using oil instead of coal, when taking into account the expenses of alteration in plant and the risk of increase in price of the oil after its general adoption. The fear of "jacking up" the price of the oil when there was a demand for the fuel prevented its more general use until the Texas and California oils were more plentiful.

Production of Texas and California Oil Wells

The production of the Texas oil wells in barrels of oil were, in 1896, 1,450 barrels; 1898, 546,070 barrels; 1899, 669,013 barrels; 1900, 836,039 barrels; 1901, 3,593,113 barrels; 1903, 18,371,383 barrels; 1905, 36,526,323 barrels; 1914, 13,117,528 barrels.

The production of the California oil wells in barrels of oil were, in 1890, 307,360 barrels; 1895, 1,208,482 barrels; 1898, 2,257,208 barrels; 1900, 4,324,484 barrels; 1903, 24,382,472 barrels; 1905, 33,427,473 barrels; 1914, 99,775,327 barrels.

We thus see that the Texas Oil wells increased the annual flow of the oil up to 1906, when they began to decrease in their flow very largely to 1915. The California wells were large producers of oil at a very much earlier date than the Texas wells, and their supply of oil has been a steady and increasing flow ever since.

An English authority in 1901 said of the Eastern oil fields: "New oil fields have been discovered and the number of places along the eastern route at which liquid fuel can be obtained has increased so enormously that it becomes a serious question for shippers to consider whether it is not an absolute economy to use it in preference to coal on vessels trading to the eastward. The solution of this question lies, first, in the cost of the fuel, and secondly, its effect on the life of the boiler furnaces in which it is burned."

What probably brought the use of fuel oil more prominently to notice at this period in this country was a series of experiments made by the United States Navy Liquid Fuel Board in 1902 and 1903, though many experiments were being made at the time by individuals and corporations along the same line.

First American Oil-Burning Steamer

The steamship *Mariposa,* of the Oceanic Steamship Company, was the first of our ocean steamships to have an oil-burning outfit installed on board the vessel. New engines and boilers had been fitted on board the vessel in 1902, and at the same time an oil-burning plant, both by the Risdon Iron Works, at San Francisco, Cal. The vessel left San Francisco for Tahiti on July 15, 1902, and burned on the voyage of about eleven days, 2,803 barrels of California oil, with a reduction of sixteen men in the firerooms. This vessel was among the first to have electric lights for interior illumination when built.

The earliest test on a long voyage was by the steamship *Nebraskan,* of the American-Hawaiian Line. This vessel was built at Camden, N. J., in 1902 and left New York on August 7 of the same year for the Pacific coast, touching at the ports of St. Lucia, West Indies, and Coronel, Chili, for coal, and reached San Diego in 57 days 5 hours and 43 minutes, consuming 2,267 tons of coal of poor quality, and having a fireroom crew of fifteen men. The vessel was under full speed during the voyage.

Economy of Oil Burners

Soon after, the Risdon Iron Works, of San Francisco, installed an oil-burning outfit, and the vessel made two voyages from the Pacific coast to Honolulu. The return voyage from San Diego to New York was commenced on February 3, 1904, and ended on March 26, with a total time on voyage of 52 days 5 hours and 3 minutes, and stoppages at the Straits of 21 hours and 37 minutes. There was a consumption of 8,826 barrels of California fuel oil for the main and auxiliary engines. Only six men were required in the fireroom. There was an increased steaming distance of 520 miles over the former voyage under coal.

It was in 1901 that the increased use of fuel oil began for marine purposes. Texas and California oil then became an important article of commerce, and it was then that the alteration of cargo steamers to oil tankers and the contracts for new oil tankers were made in this country, mainly on the Atlantic coast. It was also at this time that the Standard Oil Company contracted to build two steel hull square riggers at Bath, Me., the *Astral* and the *Acme,* and the next year the *Atlas,* a similar vessel, each over 3,200 tons, for carrying oil in packages to the East Indies. This was a period of much activity at the oil wells, as well as with the oil-carrying companies.

The Skinner & Eddy Shipbuilding Company, Seattle, Wash., is building sheds over their building ways to protectthem from the weather.

(To be concluded.)

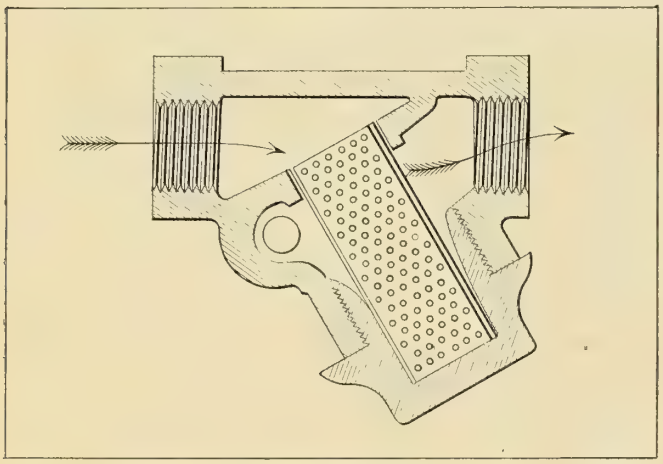
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Swing Check Converted Into Strainer

The illustration shows a strainer made from a discarded swing check valve. Having need for a small pipe line strainer for use in the air line supplying the air tools in the plant, I procured an old check valve of the swing type



Section Through Strainer

and removing the disk made a small strainer, soldering it to the cap as shown.

The strainer can be made from fine mesh wire gauze. It should be cleaned often to prevent clogging.

C. H. W.

Method of Preventing Choking of Kingston Valves

It is not unlikely that in the latitudes of Virginia and Maryland the season for ice will be practically over before this is printed. However, this may be of interest just the same.

As a rule we have very little trouble with ice on this run, and our trouble is in keeping the injection clean. We have bilge and bottom Kingston valves, and we have a 1½-inch steam pipe tapped into each of them, but continuous blowing alone will not prevent them from quickly choking up.

During the winter of 1911-12 we had a great deal of trouble with ice. One of the troubles at that time was that the holes in the strainers were so large that a great deal of ice was admitted (and pumped as far as the first tube head) that would not pass through the tubes, and the only thing we could do was wait for it to melt or take off the small plates in the main head of the condenser and dig it out; either process taking a lot of time. At the time we installed a steam connection in the condenser head to hurry the process of melting it out, but in the spring, when in dry dock, we took off the old strainer and put on others with smaller holes, so that what came through the strainer would go on through the condenser.

Our present method of dealing with this trouble (choking of the Kingston valves) is to keep both valves open and steam blowing full into the bottom one. When the condenser begins to heat, as indicated by the vacuum gage, we run the circulator alternately very fast and very slow, keeping this up until the valves are cleared. Sometimes we have to station one man at the circulator for several hours, and, if the ice is very bad, he finds plenty to do to keep himself busy.

We have installed a vacuum gage near the circulator for obvious reasons. Unless the ice is very deep—heavier, I should say, than it would be practical to run through—I think there would be little or no trouble from choking the sea valves, if they were placed as far forward as possible and piped back through a tunnel (if necessary) to the engine room.

When running through ice a large percentage of the ice passes underneath the ship, as the stream lines would indicate, instead of being divided and pushed off on either side, and, if the sea connections were well forward and at the same time as low as possible, the most of the ice would remain above them until the increasing beam of the hull caused it to pass beneath the vessel.

If any of the readers have ever seen this tried I would be interested in an account of the result.

D. Sawyer, Chief Engineer,
Norfolk and Washington Steamboat Company.
Norfolk, Va.

Four Hours Below

Rap! Rap! Rap! "It's seven bells, sir. Time to call the watch."

Out from the land of dreams the engine room messenger had awakened me, to get ready to take the mid-watch. I switched on the lights and looked at the old timepiece to make sure that I'd not been called too early.

"The old boat is restless, or we've been having a pretty rough spell," were the thoughts I had while dressing, for she was doing some rolling and pitching. "Guess there must be something doing below or else he'd let me sleep 'til quarter of." Sticking my tobacco and pipe in my jeans, I went below. On the way down I could hear the rods blowing and the old engines racing on every heave.

Landing on the floor plates, I saw the oiler handling the throttles to keep the engines from jumping off the bedplates when they raced. He looked pretty "doggoned" tired, too. I found the second assistant examining and nursing a set of hot thrust shoes on the starboard engine. His first greeting was:

"I'm d——m glad to see you. It's been a tough old watch. These shoes are giving trouble; the cooling coil in the oil well burst and washed all the oil out and we haven't got it fixed yet. The bilge strainers in the fireroom are plugged and the water is near on the plates. The rods are all blowing, due to the engine pounding and racing. Two handhole gaskets blew out on No. 4 boiler, and I've had to die her out. The port air pump has been cranky all watch, the bearings aren't any too cool; the most trouble has been with the crossheads, due to the steam blowing on them."

After getting this earful of trouble and looking things

over, I told him to go up and turn in and pray for a calm sea, so I could get things straightened out and have a smoke.

The cooling coil was cut out, the oil well drained and a few bars of yellow soap sliced up and dissolved in four buckets of fresh water. This, mixed with 5 gallons of lubricating oil and applied judiciously, cured the thrust bearing troubles.

The cleaning of fires was held up until we got the bilge strainers clear and the bilge water under control. The men on watch, being fresh, helped considerably. The crankiness of the air pump was all due to the packing of the valve stem rod being set up too tight and this on a worn rod short-stroked and sometimes stopped the throw of the valve. Slacking the gland and applying a little oil cured the trouble. New gaskets were made for the bad handhole plate seats of No. 4 boiler by taking the regular gasket and wrapping it around with a stranded lamp wicking, such as is used for oil lights. It was first soaked in a mixture of red lead and Smooth-on cement, the plate replaced carefully and set up extra tight and followed up on when the boiler formed steam.

The boiler was then refilled with hot feed water from the feed tanks, which were filled and heated during the time the boiler was being repaired. The furnaces had also been reprimed with coke and coal for lighting as soon as the gaskets were renewed. The boiler and its setting being still pretty warm, it only took a few minutes to reform steam after the repairs were completed. The boiler was needed as soon as possible, for we had two of the battery of eight opened up for cleaning, all handhole plates having been removed. This work had not been finished when we left port on this trip.

The bearings, which were running warm, were cooled with a mixture of brown soap, water and oil and were flushed with a squirt gun. A small amount of sulphur was needed to cure a cranky shaft alley spring bearing. The heated crossheads were the hardest to take care of on account of the hot steam from the blowing rods. This steam on the starboard high-pressure rod was so bad that all the oil was blown away from the oil cups. We had to stop the engine for ten minutes and renew the lower ring of packing. After this we got along all right.

There is perhaps nothing meaner than a set of badly blowing piston rod packing, and once the trouble starts there is no possible remedy for it except to stop and renew the packing. However, since this last trouble I have installed a means of lessening the leakage of steam out of the box onto the crosshead. It is to drill four ⅜-inch pipe holes at equidistant parts of the lower flange of the stuffing gland clear through and install piping with a lead to a source of vacuum, having cut out valves and proper fittings to enable work on packing gland. When the rods start blowing this line is opened to a vacuum and draws all the steam into the condenser, saving a great deal of water and keeping a cool rod and crosshead bearing. I have installed this system on the high-pressure and intermediate-pressure rods of both engines.

After about two and one-half hours of real work, the watch was again in fair condition. A cup of coffee and a pipeful of tobacco were then very welcome, but, needless to say, a good deal of nursing was required throughout the whole four hours to keep things from happening. I was, in turn, glad when it got near eight bells, to return back to my disturbed slumbers. The Chief.

Foreign Trade in American Ships.—Over 15 percent of American export trade was carried in American ships in 1916 as against less than 12 percent in 1915.

Kink for Making Bearing Liners

In the February number a letter describes a kink for making bearing liners when pouring babbit. This is all right when you have the brass, but brass is rather expensive at the present time.

If a piece of leather belting is used, I think that it will be found much easier to cut to size and will act just as well, if not better, than the brass, as it will conform to the shaft much better than the other metal and requires no hammering or filing. I have used it for years and have always found it satisfactory.

San Pedro, Cal. J. H. Cruger.

Repairs to Ash Ejector Discharge Pipe

Fig. 1 shows a photograph of an ash ejector discharge pipe which was eroded by the jet of ashes and water until the metal was entirely gone. On examination the nozzle

Fig. 1.—Fitting Patch to Ash Ejector Discharge Pipe

was found to have a scar which caused the jet to spread to the side of the discharge pipe.

The object held by the man in the photograph is the patch of ¼-inch steel plate which was forged and fitted over the opening and secured with ½-inch screws. The joint was made tight with Smooth-On.

As a repair job this was not remarkable, but it brings home very strongly the importance of care in fitting ash ejector nozzles. They must lead absolutely fair with the

center line of the discharge pipe, and if so fitted the discharge pipes should last from twelve or fifteen years.

Chief Engineer.

An Emergency Repair to a Crank Pin

Crankpins sometimes run hot, and when they do it generally means a lot of work to get them to run cool again.

I remember a small engine on an oyster boat the crankpin of which was fitted with a set of solid brass boxes. One day, while dredging, the crankpin heated up and it was found on taking down the boxes that both the pin and boxes were badly cut. There was no time to spare, so the crankshaft could not be taken out and put in a lathe to smooth the pin. That was out of the question. So another way had to be found which would save time and expense.

This is how it was done. The boxes were scraped until they were smooth. Next, two narrow pieces of board that were about the same width as the strap and about a foot long were found and holes bored at each end of each piece.

Two strips of emery cloth were then torn off just the width of the boxes, one piece being tacked on to each of the boards, emery side down. Each of the boxes was then laid on one of the boards and the emery cloth laid over the end and onto the wearing surface.

The boxes were then put on the pin, bolts put through the holes in ends of boards and tightened up to hold the device in position while it was being turned.

Turn the device by hand in the same direction in which the boxes run when the engine is running, tightening the bolts from time to time to keep the emery cloth cutting. In a few hours the job can be completed and the boat put into service again.

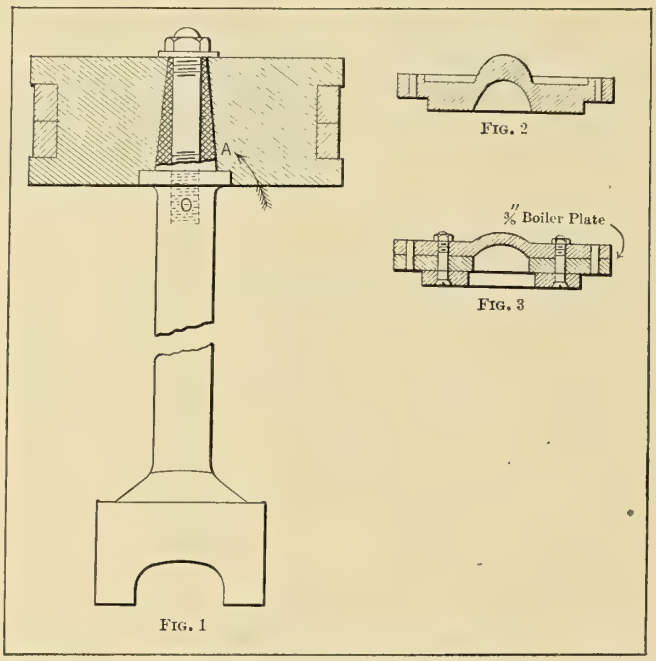
Tiverton, R. I. Joseph Church, 2nd.

Breakdowns

While serving as a junior engineer on a tramp steamer that wandered into many strange ports far from real civilization, I received some pointers on the art of making repairs with very limited equipment and supplies. Many's the time we have left port loaded down below the insurance draft marks, and struck a rough, nasty sea. That kept everybody's eyes wide open to see that the old engine did not stop or develop any trouble. To break down in a bad spell of rough weather, with a ship loaded clear to the gunwale, generally means that she will swamp and founder.

It was during one of these trips, about two days out of port, that I experienced my first breakdown at sea. A piece of the gasket under the high-pressure cylinder head blew out; this was not exactly a breakdown, because nothing was broken, but it was nearly as bad as if something was. The piece blown out was of sufficient size to allow the steam under high pressure to escape in such volume that it was quickly filling the engine room and making it very hard to breathe. We notified the captain on the bridge and he said we could slow down but must not stop. It was imperative that the ship's headway be kept so that we could keep out of the trough of the sea.

We slowed down to about 48 revolutions per minute, and this gave 55 pounds on the high-pressure cylinder. With this blowing, we made the repairs by a number of small wedges out of strip copper and sheet steel wedges. The space between the head and the cylinder was about 3/64 inch, the gasket being ⅛ inch. The placing of these wedges was accomplished by myself and two others, each one taking turns; our heads, hands and bodies being wrapped in wet burlap and cloths. We would place a wedge, then drive it, and each one made the leak a little less, until it was fairly easy to get at. Some of the wedges blew out and had to be driven over again. As soon as we got a few in place and could see what we were doing we braced them from blowing out. This repair enabled us to keep the engine going in a time when stopping would probably mean not only the loss of the ship but perhaps our own lives. Although the leak was not stopped so that no steam blew out, it was stopped so that there was but a small hiss and vapor. It does not take very much of a



Repairs to Piston Rod of Blower Engine

volume of steam to take all the oxygen out of the air, and a fellow can't breathe or live very long without oxygen.

Another time, when one of the blower engines was being run for all it was worth to force the steaming on a special trip, there came a rattling noise; the water tender sprang to the blower throttle to stop it, but he was too late. With a crashing noise it stopped and pieces were flying in all directions. On examination it was found that the cylinder head was broken out, and the piston rod broken and bent. Fig. 1 shows the repair made to the rod, which broke at *A*, the piston and upper part of crosshead being one piece, as shown. Not having a spare, it was urgent that we make some sort of repair. A large stud was made and the end of the rod drilled and tapped for it. This was screwed in tightly and pinned; the rod placed in the solid piston, and babbit metal was poured around the stud to fill in to the taper. This made a very good repair.

The cylinder head was of the design shown in Fig. 2, and as it was entirely ruined a new one had to be made from pieces of ⅜-inch boiler plate, as shown in Fig. 3, reinforced with bolts, and a gasket used in between each plate. These plates were drilled out and trimmed up with an air hammer, the top plate dished upwards at the center by heating and peening.

The wreck of the engine was laid to the flaw in the break at *A* of the rod. After these repairs were made, the engine was run at half speed, 300 revolutions per minute.

C. H. W.

Notes on Boiler (B. & W. Type) Operation Aboard Ship

The following notes may be of interest to engineers who have charge of vessels equipped with watertube boilers:

Making Ready to Light Off

Take off the stack covers, open the dampers, and try them out to see that they open and close properly. Examine the side casing doors, and see that they are dogged up tight. This is an important item in case of a tube giving out. If they are properly secured, they will stay shut and the steam will go up through the stack instead of into the fireroom. Make an examination of all the boiler fittings; they should be in the following order for lighting off:

Main stop valve, shut but eased on its seat; main and auxiliary feed stop valves open wide; main and auxiliary feed check valves closed; surface and bottom blow valves closed; try cocks closed; air cock open till steam is formed; water column valves opened; the drain valve to bilge used for blowing down glass should be closed; steam gage connection valve open wide; safety valves should be raised by hand and then seated; this to make sure that they are not stuck.

If all valves are in the above condition, you are ready to prime the furnaces. It is well to have a look in them to see that the grates are all in place and clear of any tools. In most ships the firemen have a habit of putting shovels and tools in on the grates of a dead boiler.

Priming and Lighting Off

Make sure that idle boilers have their dampers and ash pans closed tightly when they are connected to the same stack as the boilers to be lighted or steaming. This prevents loss of draft.

Run the water in the boiler down to steaming level, which is about halfway of the gage class. Next try the feeding of the check valves; you can feel the water pass through, or the click of the check is heard.

Cover the grate surface with 3 inches of dampened coal (dampening it prevents the fine coal from falling through the grates). Leave about 1½ feet of the grate surface near the doors bare. If there are any other boilers steaming, procure live coal from them and place enough of it on the bare grate to light the boiler (generally about two shovelsful to each door is plenty). If no live coal is obtainable, use wood and oily waste.

The fire should be kindled near the furnace doors, and worked back over the green coal. Leave each furnace fire door open a small amount to admit air over the grates until the fires are going well and drawing air through the grates. If steam is required to be raised in a hurry, then use all the inflammable combustibles on hand and very small lump coal; don't wet and don't work it too much.

Make sure that the fireroom ventilator is trimmed to the wind, in order to get all the draft possible. Use a short, small slice bar for working the fire until you have it built up and lower the level of the water in the steam drum to about one inch in the bottom of the glass; this gives you less water to heat and in careful hands there is no danger in water at this level, especially when starting fires. The water expands some and will reach the center of the glass by the time steam is raised. Plenty of dry lump coal is mighty handy for rushing a fire along. The lumps should be one inch in size.

While the steam is forming you can examine the boiler casing for air leaks into the combustion chambers. Have the front and back header casing doors loosened and a couple of hand hole plate wrenches handy for setting up on any leaky plate gaskets that might develop; this often saves dying out fires to renew one.

When steam blows through the air cock for a few minutes, shut it and keep your eye on the steam gage; should it fail to register any pressure within a reasonable amount of time, blow the drip cock at the bottom of the gage just a little, for it might be a little stiff and this will move it. Do not blow all the water out of the steam gage line, as heating up the tube of the gage injures it and it will not register properly.

When you have 10 pounds pressure, try out the water column to see if it is clear, also the try cocks. If the boiler is needed in a hurry, when the steam pressure is equal to that of the other boilers in use you can slowly cut it into the line. But if time can be taken, it should be allowed to raise the pressure until the safety valves blow; then let it come down by checking the combustion, and when about even to the pressure in the line, cut it in, always bearing in mind that you are controlling an enormous energy and that the valves have to be handled very carefully to prevent damage. Some plants are fitted with a small bypass valve on all stop valves; these serve the purpose of slowly equalizing the pressure.

Hand Firing Soft Coal

No hard and fast rule can be laid down as the best for firing all qualities and kinds of coal, but a few general hints or instructions will aid in obtaining good results. Systematic time firing is perhaps the nearest to being the correct way of firing by hand. The intervals of time between each coaling of each door of the furnace should be so regulated that only four shovelsful are required to be fed at a time, and yet keep the fires of about 6 to 8 inches thickness for natural draft (about 12 to 14 inches under forced draft).

Rapidity is desirable in charging the furnace with coal in order to cut the time down that the door is open, but combined with this good judgment must be used in placing or spreading the coal evenly over the fire, thus saving considerable use of the leveling hoe. The proper method to use in firing a six-door furnace is as follows: Number the doors from left to right, 1-3-5-2-4-6. At each interval of time, say three and a half minutes, the doors are fired in order 1-2-3-4-5-6, and the adjacent doors are leveled and sliced as needed.

Holes and clinkers must be removed as soon as found. Never cover a hole with green coal and do not wait until cleaning fires to remove bad clinkers. Keep all the coal broken up in small lumps about 2 inches in size, and if you have a run of very fine dusty coal sprinkle it lightly with water before firing. If you don't, it will mostly go up the stack when you have a good draft. Some engineers will not wet fine coal, claiming that the wet coal will stick to the heating surfaces of the tubes and that it is a direct loss of efficiency. This may be true, but it is easy to blow tubes once a watch to offset this, and if the coal is not soaked and only sprinkled it will not bother the heating surface.

There are many firemen who forget that the best part of the grate is at the back; the fire there should be the hottest. It is the hardest part of the grate to get at and is often neglected. Try and keep it bright in the ash pan and you will be well repaid in easy steaming.

Never under any circumstances raise the slice bar clear up through the fire. This mixes ashes with the live coal and causes fusion of the ash into clinker. The proper way to slice a fire is to work the bar in over the grate back

to the bridge wall and then swing it to the right and left without raising. If it is necessary to break up a crust on the fires after clearing the ashes as described above, the bar can be raised enough to just break up the fire.

Cleaning Fires

Fires ought to be cleaned at regular intervals of time—the cleaning should start about twelve hours after the fires have been started. Two doors of each set of six should be cleaned on each boiler every four hours, about as follows, The 4 to 8 watch cleans No. 1 and No. 2 fires, 8 to 12 cleans No. 3 and No. 4 fires, 12 to 4 cleans No. 5 and No. 6. This cleans each fire once every twelve hours.

The fires to be cleaned by the watch coming on should, if possible, be allowed to burn down a few minutes before the relief comes on. In burning down a fire for cleaning the coaling of that door is omitted and the coals burned to ash; yet these must be kept well spread over the grates, so as to keep them covered and prevent cold air getting in. While these cleaning fires are being burned down, the adjacent or wing fire must be built up in order to have plenty of fire to bring over on the grate which is cleaned.

When ready to pull a cleaning fire, lead out the wetting down hose, close the ash pit door of the fire to be cleaned, and with a short, light hoe pull out the front half. The slice bar may be needed to break off the clinkers that stick to the grates. A small amount of water kept in the ash pans will keep clinkers from sticking to the grates. After pulling the rest of the fire wing over the top of the live wing fire and coal over lightly with green coal; after it is going pretty good it can be built up.

It is best to plan the cleaning fires so that only about half the boilers are cleaned at one time, and if more than one stack is in use, divide them between the stacks. This does not spoil the draft of the stacks.

Tending Water

Steady and uniform feeding and maintenance of the water level is productive of economical and good steaming. Babcock & Wilcox, or in fact any watertube boiler, requires a close watch of the water level; the water space being small and the rate of evaporation very rapid. It should be borne in mind that the feed stop valves should be wide open and should never be closed while the boiler is steaming, not even for a minute. The regulating of the feed supply of each boiler differs; one boiler may require more feeding than another. Frequent adjustments of the feed checks are required to maintain a proper supply of feed water; the checks should never be closed tight, it is bad practice.

High Water.—This is as dangerous in some respects as low water, for a high water level in the steam drum will carry over wet steam into the piping and engines, causing water rams in the steam lines. This is liable to rupture them, or, if the steam lines escape damage, an engine cylinder may be flooded and burst a head. High water may be caused by inattention or a badly leaking check valve, such as one which may have something under the valve disk. In a case like this is the only time that the feed stop should be used for regulating the feed. This is a very unsatisfactory manner of feeding and is not safe. When these derangements of the feed checks occur, the best thing to do is to die out or bank the fire and make the proper repairs.

Low Water.—No specific instructions can be given that would cover the many different cases of low feed water. Most of the trouble comes from lack of proper attention on the part of the water tender, a few of the other causes being low water in the feed tanks; breakdown of the feed pumps or poor working; gaskets blown out of the feed line joint, causing large leakage; failure of automatic devices on the feed system; or too hot feed water. It is the most dangerous and frequent trouble of the fireroom.

Many times a water tender's duties will take his attention from the checks, but a careful and competent fireman should first be placed in charge of them. At the first sign of low water the fires must be checked, and if they are extra hot, besides closing the dampers and ash pans cover them with plenty of wet green coal. Never attempt to feed the boiler when you have lost the water out of the try cocks or water column for more than a minute. If you cannot locate the water level, the fires should be put out and then hauled. Never attempt to haul a hot fire; it generates more heat when you stir it up in hauling. Shut the boiler stop valve and feed stops and very gradually raise the safety valves by the hand-lifting device.

If a fire extinguisher system is fitted it should be used. There are too many people in charge of boilers who are willing to take a chance at feeding a boiler when the water has gone out of sight. But it has been the writer's observation that many thousands of dollars' worth of damage is caused by distorted tubes, burnt and bagged boilers, and many fatal accidents are caused by failure to follow the "Safety First" slogan of carrying out the above instructions for low water.

The water tender's duties are most important ones and only competent men should be selected to fill these billets.

Men and Tools

The skill of a fireroom force is soon apparent in the manner that the fires are kept and the appearance of the fireroom in general. No steaming watch should be over four hours in length and the men should have at least eight hours rest between watches. Fresh firemen are the best and most economical. Overworked, tired firemen do not show any interest in their work; a little coffee and meat for night watches does a good bit towards contentment. Provide good boiler tools, sharp-pointed slice bars made of good quality steel that will not bend too easily, steel scoops which will hold a good bit of coal, rakes and leveling hoes which are light and easy to handle, lengths of air hose and pipe lances for cleaning tubes, light weight durable coal buckets for handling the coal, a sufficient number of men to properly run the watch, and you will get good results.

C. H. W.

Correction.—In the article on the Mono Marine CO_2 Recorder, published on page 66 of our February issue, a regrettable error was made with reference to the boilers of the steamship *Kristianiafjord*, of the Norwegian-America Line. This statement read as follows: "It was found that with a high percentage (from 11 to 12 percent) of CO_2 present carbon monoxide to the extent of one percent was also present, resulting in fuel loss, while, on the other hand, with Babcock & Wilcox watertube boilers, when the CO_2 averaged around 10 percent, hardly any carbon monoxide was present, indicating ideal conditions of combustion." As a matter of fact, this vessel was not equipped with watertube boilers, but with Scotch boilers, and the improved conditions of combustion were due to the installation in the furnaces of the Scotch boilers of Wager patent bridge walls, as manufactured by Robert H. Wager, 149 Broadway, New York. The improved conditions of combustion brought about by the installation of these patent bridge walls was revealed to the firemen by means of the Mono CO_2 recording instruments, the records of which showed the firemen just what percentage of CO_2 to carry to obtain the best results.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with the cards.

Analysis of Indicator Cards from Triple Expansion Engine

Q.—Please give your opinion of the indicator cards inclosed herewith as to the horsepower developed; also advise me if I have measured the high pressure card correctly? My chief argues that I should measure from the atmospheric line to the steam and expansion lines, whereas I have measured from the top of the card to the bottom, or from the steam to the exhaust. Isn't this engine poorly balanced and the high pressure cylinder doing the least work? A. J. M.

A.—In working up the cards for mean effective pressure, measurements should be taken from the top, or admission, line of one card to the bottom, or exhaust, line of the *same* card and the atmospheric line does not enter into the calculation in any way; in fact, it could be omitted. It is only when we wish to know the pressure in the cylinder at some *instant* that we need the atmospheric line, for then the measurement from the atmospheric line to the point under consideration gives the pressure, as a gage would give it, above the atmospheric pressure. Be careful, however, to take the measurement for *M.E.P.* between the two lines of the same card, as from the cards it appears that you occasionally have used the admission line of the head end diagram with the exhaust line of the crank end diagram. If there is any confusion it is better to take separate cards for each end.

The correct mean effective pressures of the cylinders are as follows:

High-pressure cylinder, top	74.0
High-pressure cylinder, bottom	67.0
Intermediate-pressure cylinder, top	41.2
Intermediate-pressure cylinder, bottom	36.1
Low-pressure cylinder, top	13.3
Low-pressure cylinder, bottom	11.5

As size of piston rod was not given, the following was taken:

$$\text{Area of rod} = \frac{\text{Boiler pressure} \times \text{area H. P. piston}}{\text{Safe working stress}}$$

$$= \frac{190 \times 363.05}{3{,}000} = 23.0 \text{ square inches.}$$

Horsepower calculation:

H. P. cylinder, top,

$$\text{H. P.} = \frac{74.0 \times 3.5 \times 363.05 \times 72.4}{33{,}000} = 206$$

Bottom,

$$\text{H. P.} = \frac{67.0 \times 3.5 \times (363.05 - 23.0) \times 72.4}{33{,}000} = 175$$

I. P. cylinder, top,

$$\text{H. P.} = \frac{41.2 \times 35 \times 1017.9 \times 72.4}{33{,}000} = 322$$

Bottom,

$$\text{H. P.} = \frac{36.1 \times 3.5 \times (1017.9 - 23.0) \times 72.4}{33{,}000} = 276$$

L. P. cylinder, top,

$$\text{H. P.} = \frac{13.3 \times 3.5 \times 3117.3 \times 72.4}{33{,}000} = 318.5$$

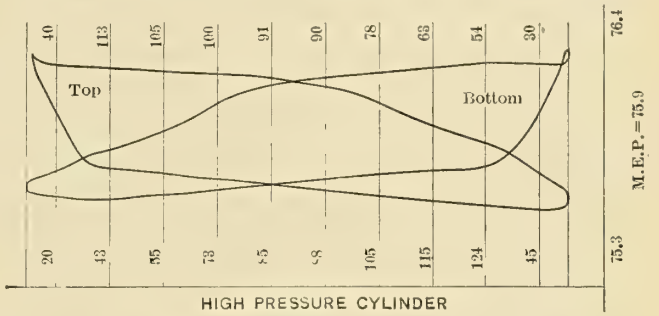
Bottom,

$$\text{H. P.} = \frac{11.5 \times 3.5 \times (3117.3 - 23.0) \times 72.4}{33{,}000} = 274$$

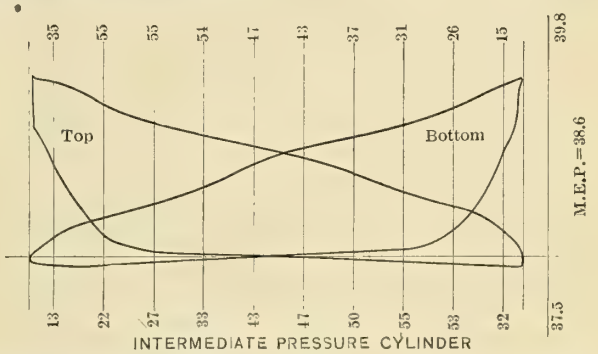
Total H. P = 1571.5

Horsepower: H. P. cylinder, 381; I. P. cylinder, 598; L. P. cylinder, 592.5; total, 1571.5.

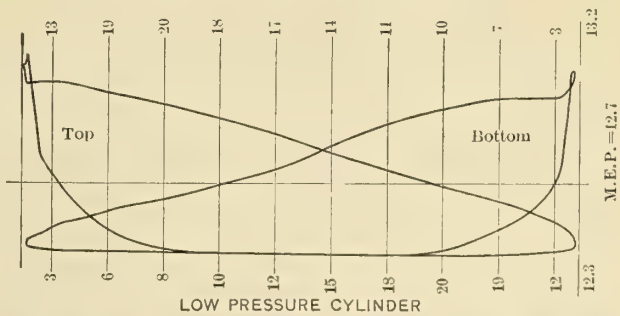
From this it is evident that the high pressure cylinder is doing much less than its share of the work and the



Diameter, 21½ Inches; Stroke, 42 Inches; Cut-off, 30¾ Inches; Scale of Spring, 100; Boiler Gage, 190; Vacuum Gage, 22½; Revolutions per Minute, 72.4.



Diameter, 36 Inches; Stroke, 42 Inches; Cut-off, 30 Inches; Scale of Spring, 50; Boiler Gage, 190; Vacuum Gage, 22½; Revolutions per Minute, 72.4.



Diameter, 63 Inches; Stroke, 42 Inches; Cut-off, 19 Inches; Scale of Spring, 16; Boiler Gage, 190; Vacuum Gage, 22½; Revolutions per Minute, 72.4.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

striking feature of the diagram is the excessive rise in pressure in the exhaust line. This ought to be nearly horizontal for an engine of this character. This rise is caused either by restrictions in the passages from the high pressure cylinder to receiver or too small exhaust port opening. To remedy it, first make sure that the passages from cylinder to receiver are without obstructions, sharp corner turns, etc. If nothing is found here, increase the maximum port opening for exhaust (by cutting down the exhaust lap of the valve, if it is a direct valve), and then readjust the eccentric (increase the angular advance) to retard all events. (See the answer to R. E. C. in this issue.)

The intermediate and low pressure cards are not bad as they are, but both would be improved by decreased angular advance of their eccentrics in order to delay the events, especially the compression. If the engine is equipped with Stevenson link valve gear, work the gag screws for these cylinders to give later cut-offs, and it will probably adjust these cards and also help equalize the power distribution, as this adjustment takes work from the intermediate pressure and low pressure and throws it into the high pressure. It may be that the whole engine is "linked-up" too much, and you might try cards with her opened out a bit before making any other changes.

Steam Consumption of Evaporators

Q. (866).—Will you kindly tell me through your interesting column what is considered a reasonable performance in pounds of water evaporated per pound of steam used, for modern evaporating plants used for make up feed on board ship?

A (866).—From 1 to 1½ pounds of water per pound of steam is common everyday attainment with evaporators using single or double effect, and as high as 3 pounds of water per pound of live steam has been obtained with some types of evaporators.

"Proximate" and "Ultimate" Coal Analyses

Q. (865).—Will you please tell me the difference between "proximate" and "ultimate" coal analyses, as used in boiler tests?

A (865).—The "proximate" analysis gives the percentage of each independent *compound,* as moisture, ash, fixed carbon and volatile matter.

The "ultimate" analysis gives the percentages of each chemical element as carbon, oxygen, sulphur, hydrogen and nitrogen.

Calculations for Capacity for Boiler Feed Pumps

Q. (867).—How would you find the capacity of force pumps for a battery of six boilers, each boiler 42 inches diameter and 30 feet long, steam pressure allowed 175 pounds per square inch, for two high pressure poppet valve engines, each cylinder 26 inches diameter by 9 feet stroke of piston?

A (867).—As enough data are not given, 200 pounds of water per square foot grate surface per hour, and 130 square feet grate surface were assumed for this type of boiler, as is the case on some Western river steamers.

Total water evaporated = $200 \times 130 \times 6 = 156{,}000$ pounds per hour. The capacity of each feed pump is customarily twice the net feed of the boilers it handles, and we may assume one pump of the above capacity to each *three boilers.*

Head to be pumped against = $175 \times 2.31 = 404$ feet. Friction of valves = 20 percent of boiler pressure.* $.2 \times 404 = 80.8$. Total head = 485 feet.

$$\text{I. H. P. of pumps} = \frac{156{,}000 \times 485}{60 \times 33{,}000 \times .65} = 58.8.$$

Use 60 horsepower per pump where 65 percent is mechanical efficiency of pump.

* "Steam Power Plant Engineering," Gebhardt, p. 599.

As insufficient data were furnished for accurate solution, it may best be said that the total indicated horsepower of the pumps should be 120 as a minimum.

Safe Working Pressure of Boiler

Q. (871).—What is the safe working pressure of a boiler 38 inches diameter made of plate 26/100 inch thick of 65,000 pounds per square inch tensile strength?

A (871).—

$$\text{Formula: } p = \frac{tfe}{r}$$

p = internal pressure,
t = thickness,
f = maximum allowable stress = $\frac{65{,}000}{5}$. (Factor of safety = 5.00, Massachusetts Boiler Rules.)
e = joint efficiency, assumed 60 percent.
r = radius of drum.

$$p = \frac{0.26 \times 13{,}000 \times .60}{19} = 106.7 \text{ pounds per square inch.}$$

Mast, Boom and Rigging Design

(*Concluded from page* 101.)

The radius of gyration of the angle stiffeners should be found with regard to axis of the spar. The weight of the structure should be roughly found and included in the stress.

In the case of the boom, L, the unsupported length, is that distance from center line of end block to center line of connecting pin at mast or boom table. In the case of the mast, L is the distance from topping lift connection to the point where the boom connects to the mast or, in the case of boom tables, to the upper deck.

The shear at the upper and lower decks is the total load on boom times its distance from the center line of the mast divided by the 'tweendeck height.

The boom is subjected to bending, due to its own weight when knot is used, due to its outer end resting on deck supports.

At decks and where the boom connects to the mast, the mast plating should be doubled to give sufficient area to resist the shear. The deck connections must be designed for shear. The deck plating adjoining the mast on the upper deck should be doubled and adjoining beams be made heavy. The deck carrying the most should be amply strengthened to take the compression without buckling. The load is usually carried to the bottom by stanchions.

Only in the case of very heavy booms need bending, due to its own weight, be considered.

The mast is subjected to a maximum bending moment due to the thrust in the boom when the latter is at right angles to the mast. In this case, the bending moment is equal to the thrust in the boom times the distance on the mast from the topping lift to the boom connection. It will be well to check the dimensions obtained by considering only compression to be assured that the spar can carry this safely. This bending moment will, as a rule, be greater than the one caused by the horizontal reactions at the decks in all ordinary conditions.

The standing rigging should in all cases be protected against rust and deterioration by painting or other means. The running rigging may be protected by a grease compound which will protect it from the elements as well as cut the friction in the blocks when in use.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The demand for ship plates has predominated in the steel market during the past month. Inquiries involving upwards of 200,000 tons of such material have been made, the deliveries ranging from six months to the early part of 1919. These inquiries have come not only from domestic yards but also from France and Japan.

The Naval Appropriation Bill, just passed by the House, provides for a total expenditure of $368,553,388, the largest in the history of the country. The building programme includes 40 ships in all, consisting of 3 battleships, 1 battle cruiser, 3 scout cruisers, 15 destroyers, 1 destroyer tender, 1 submarine tender and 18 submarines. Fifty more submarines, 10 of the cruising type and 40 of the coast defense type, have been provided by the Senate Naval Committee, and the House appropriation has been raised to nearly half a billion dollars.

Bids for 6 new scout cruisers will be opened by the Navy Department on March 14. The six cruisers include three of the four authorized last year and the three included in this year's programme. The limit of cost of each vessel, however, has been raised from $5,000,000 to $6,000,000.

Raymond B. Stevens, a former congressman from New Hampshire and more recently special counsel for the Federal Trade Commission, has been nominated by President Wilson for the five-year term to the United States Shipping Board made vacant by the resignation of Bernard N. Baker, of Baltimore.

American Merchant Marine Statistics

The following table shows the number and gross tonnage of merchant vessels of the United States registered for the foreign trade and enrolled and licensed for the coasting trade and fisheries on the dates named, as reported by the Bureau of Navigation, Department of Commerce:

	Registered.		Enrolled and Licensed		Total	
Date.	No. of Vessels.	Gross Tons.	No. of Vessels.	Gross Tons.	No. of Vessels.	Gross Tons.
June 30, 1916...	3,134	2,191,715	23,310	6,277,934	26,444	8,469,649
Sept. 30, 1916...	3,187	2,169,338	23,323	6,352,319	26,510	8,521,657
Dec. 31, 1916...	3,242	2,201,103	23,166	6,384,161	26,408	8,585,264

Current American Shipbuilding

Returns received by the Bureau of Navigation, Department of Commerce, show that at the beginning of the current year American shipyards, including United States navy yards, were building or had undertaken to build 682 vessels of 2,098,761 tons. These figures present the situation as it existed on January 1, 1917, and they include ships of all kinds in all stages of construction from United States battleships, the contracts for building which were only recently made, and wooden schooners of 500 gross tons. Merchant shipping is expressed in gross tons, while naval tonnage is expressed in displacement tons, and addition of the two is arbitrary, merely to reach a total.

The tonnage of sixty-one submarines building is not stated for obvious reasons, and not included in totals. Submarines range from 400 tons displacement to over 1,000 tons.

The tonnage may be thus summed up:

Kinds	Number	Gross Tons
Steel merchant ships	403	1,495,601
Wooden merchant ships	161	207,623
Total merchant construction	564	1,703,294
		Displacement, Tons
Government vessels:		
Steel, navy yards and private yards	118	395,537
Grand total	682	2,098,761

During January new contracts for twenty-four steel vessels of 77,830 gross tons were entered into by American shipyards. On February 1, accordingly, American private shipyards were building or under contract to build 415 steel merchant ships of 1,529,854 gross tons.

Opponents of the Metric System Organize

The American Institute of Weights and Measures was organized recently by engineers and manufacturers who are opposed to the adoption of the metric system of weights and measures in American industrial and commercial life. The officers elected by the new organization were as follows: President, W. R. Ingalls, editor of the *Engineering and Mining Journal* and President of the Mining and Metallurgical Society of America; vice-presidents, Henry D. Sharpe, treasurer of the Brown & Sharpe Manufacturing Company, and D. H. Kelly, secretary of the Toledo Scale Company; treasurer, William M. Macfarland of the Babcock & Wilcox Company, and secretary, F. A. Halsey, editor emeritus of the *American Machinist.*

Shipbuilding Contracts

The Southern Pacific Company, operating the Morgan Line, Pier 49, North River, New York, Captain C. W. Jungen, manager, is reported to be in the market for four freight ships, each of 11,000 tons and two passenger vessels, each of 10,000 tons. At last reports, orders for these vessels had not been placed.

It is reported that the Union Iron Works Company, San Francisco, Cal., has received a contract to build three 10,000-ton steel freighters for British firms.

It is reported that two steel oil tank steamers have been designed for the Southern Oil and Transportation Company, New York, and that these ships will be built by the Tank-Ship Building Corporation, Newburgh, N. Y.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has a contract to build eight wooden hull motor ships, each 280 feet long.

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Rolph Navigation and Coal Company, San Francisco, to build two 135-foot ocean-going tugs.

The Standifer-Dix-Clarkson Shipyard, Inc., Portland, Ore., will build a 2,500-ton wooden steamer for Libby, McNeill & Libby, Portland.

It is reported that the Supple Shipyards, Portland, Ore., have received contracts to build two 300-foot composite vessels to cost $750,000.

The Clooney Construction Company, Lake Charles, La., will build a 208-foot steel hull for the Gulf Export and Transportation Company, Beaumont, Tex.

It is reported that the Elliott Bay Yacht & Engine Company, Seattle, Wash., has just secured contracts to build five small vessels.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Standard Oil Company, New York, to build an oil tank steamship for use on the Great Lakes. It is stated that this tanker will be 434 feet long and will have a capacity of 2,700,000 gallons of oil.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., to build two more freight steamers.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., is building a 12,000-ton motor ship, 240 feet long, to be equipped with two Diesel engines.

The Washington Overseas Shipbuilding & Construction Company, Seattle, Wash., has received a contract to build four auxiliary five-masted wooden schooners.

The Matthew Shipbuilding Company, Hoquiam, Wash., will build a steam lumber schooner for the Hart-Wood Lumber Company, San Francisco, Cal.

The Navy Department, Washington, D. C., has awarded a contract to build an ammunition ship to the Puget Sound (Wash.) Navy Yard.

The Naval Committee of the House of Representatives has completed the 1918 Naval Appropriation Bill, carrying a total of more than $350,000,000. It provides for the construction of three 42,000-ton battleships, one battle cruiser, three scout cruisers, fifteen destroyers, one destroyer tender, one submarine tender and eighteen submarines.

(Photograph by Press Illustrated Service, Inc., N. Y.)

War Time Activity at Bordeaux, the Main Port of France

Shipyard Notes

The keel of the battleship *Maryland* will be laid at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., on April 1.

The Seattle Construction & Dry Dock Company, Seattle, Wash., which has recently completed improvements to its plant costing about $100,000, is planning to spend $150,000 more for improvements.

It is announced that Wallace Downey of the Standard Shipbuilding Company, New York, has disposed of his interest in the company. Mr. Downey is reported to have bought the plant of Milliken Bros. on Staten Island, and he states that plans are already in preparation for the installation on this property of several 10,000-ton shipbuilding berths; also steel plate furnaces and plate rolls. He announces that a corporation will be organized to operate the plant.

Harry Cossey, Tottenville, Staten Island, N. Y., plans to double the capacity of his shipbuilding plant.

It is reported that P. J. Donohoe of Seattle, Wash., and associates, will erect a shipyard at Aberdeen, Wash.

The McEachern Shipbuilding Company, Astoria, Ore., is reported to have been purchased by A. O. Anderson & Company, who plan extensive improvements.

The Western Boat Building Company, Tacoma, Wash., has been incorporated, with M. A. Petrich as manager. The new company is reported to have already received contracts to build four boats.

The Standard Shipbuilding Corporation, New York, operating a plant at Shooters Island, has applied to the New York Harbor Line Board for permission to add a tract of thirty-five acres to Shooters Island to be used for extending its plant.

The Newark Boat Works, with offices at 756 Broad street, Newark, N. J., has been incorporated, with a capital of $125,000.

The Red Bank Yacht Works, Red Bank, N. J. ,has been incorporated, with a capital of $100,000. P. A. Proal and M. M. Proal, 30 Front street, Red Bank, are among the incorporators.

The Sloan Shipbuilding Company, Olympia, Wash., has been incorporated for $1,000,000 and has purchased a site in Olympia. It is stated that work will begin at once on yards and slips. Philip D. Sloan is president.

The Marine Works, Seattle, Wash., has been incorporated, by P. C. Peterson, F. Batten and C. Nelson.

The Howard Shipyards and Dock Company, with offices at 1 Wall street, New York, has been organized to take over five shipyards of the old Howard Company at Jeffersonville, Ind., and others. It is stated that about $4,000,000 will be spent in improving these yards.

The National Shipbuilding Company, Seattle, Wash., has been incorporated by F. C. Norbeck and O. D. Trieber.

The Scandinavian Shipbuilding Company, Seattle, Wash., has been incorporated by J. W. Bowerman and Carl W. Isakson.

It is announced that a large floating dry dock is to be built at Vancouver, B. C., by the Vancouver Dry Docks, Ltd. The newly organized company also plans the erection of a shipbuilding plant.

The Hook Foundry Company, Marcus Hook, Pa., recently organized, with a capital of $50,000, has purchased a site of two acres for the erection of a foundry to specialize in ship castings. James B. Strain, Chester, Pa., is head of the company.

A plate shop, 120 by 400 feet, will be erected by the Standard Shipbuilding Company, New York, at its plant on Shooters Island, in connection with other additions.

Francis J. Donald, president, the Philadelphia Ship Repair Company, Philadelphia, Pa., is organizing a company to take over and operate the Atlantic City (N. J.) Steamship Line, which recently suspended operations. The new company plans for the erection of a cold storage plant and coal plant at Atlantic City. Warren Webster, Camden, N. J., is also interested in the company.

In a recent report by the Commission on Navy Yards and Naval Stations, of which Rear-Admiral J. M. Helm, U. S. N., is chairman, recommendations were made for appropriations of $1,500,000 towards the acquisition and development of sites for additional navy yards on San Francisco bay; $2,250,000 towards the development of the Mare Island Navy Yard, and $2,500,000 towards the development of the Puget Sound Navy

(Copyright by Underwood & Underwood, N. Y.)

United States Army Transport *Sumner* Breaks Amidships on Shoal Off Barnegat Light

The United States Army transport *Sumner*, which went aground on December 11, 1916, has been broken in two amidships by the pounding of the waves. The vessel is practically a total loss.

(Copyright by Underwood & Underwood, N. Y.)

Sir Ernest Shackleton's Polar Expedition Ship *Endurance* Going Down in the Weddell Sea on August 1, 1915

The *Endurance* was hove bodily out of her bed and heeled over, breaking her rudder. In October she broke clear of the floe, but soon there was renewed pressure, and she was thrown on the ice again. A few days later she was squeezed again by the ice and her hull caved in under heavy pressure. The vessel was immediately abandoned, and when the pressure was released she slipped down through the ice, breaking off her masts and rigging, as shown in the photograph.

Yard. This commission also recommends that a proviso be inserted in the current naval appropriation bill authorizing the Secretary of the Navy to accept a tract of land comprising about 166 acreas of submerged land in Los Angeles harbor, which has been offered to the United States free of cost by the city of Los Angeles for the purpose of establishing therein a submarine base. The commission recommends an appropriation of $300,000 towards the development of this base and similar legislation with an appropriation of $500,000 for the establishment of a naval aviation base on San Diego bay.

Bids Asked for Towboats and Vessels of 1000 to 3000 Tons Deadweight Capacity

A foreign correspondent asks Marine Engineering to secure bids for the construction of a considerable number of towboats, each to be about 125 feet and to have about 500 horsepower. Steel hulls preferable. Communications will receive prompt attention.

Another correspondent asks for bids on hulls of from eight to twelve vessels, varying from 1,000 tons D. W. to 3,000 tons D. W. Steel hulls preferred. They are to be built complete ready for oil engines to be installed, the engines to be provided by the correspondent.

Marine Terminal Improvements

The Port of Genoa, Italy, is planning to spend about $3,000,000 in docks, piers and other harbor improvements.

The Delaware, Lackawanna & Western Railroad Company, G. J. Ray, Hoboken, N. J., chief engineer, plans to build piers at the foot of Eleventh street, Hoboken.

The City of Duluth, Minn., L. Ayres, city engineer, is planning the erection of a coaling dock.

The Southern Pacific Company, operating the Morgan Line, Captain C. W. Jungen, manager, Pier 49, North River, New York, is planning to build reinforced concrete piers at Galveston, Tex.

The Board of Commissioners, Port of New Orleans, has let a contract to J. Riess, Hibernia Bank Building, New Orleans, to build a wharf and causeway at a cost of $92,644.

The State Board of Harbor Commissioners of California has let a contract to build Pier No. 3 to J. B. Hannah, Chronicle Building, San Francisco, at a cost of $248,000.

The St. Lawrence Marine Railway Company, Ogdensburg, N. Y., is planning to build nine piers.

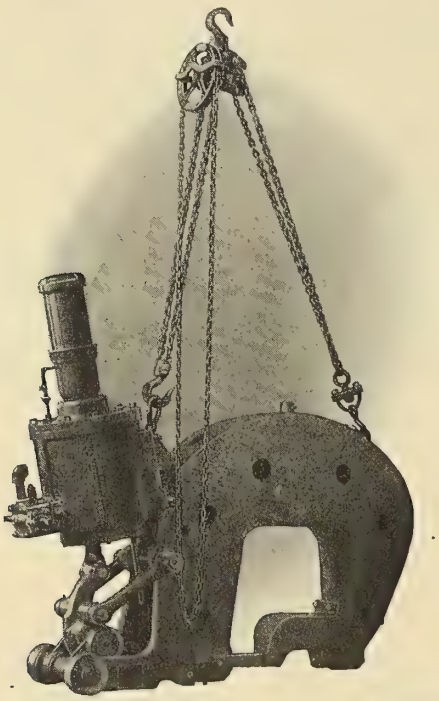
The Department of Wharves, Docks and Ferries, Philadelphia, Pa., W. S. Webster, director, is planning to build a pier at the foot of Wolf street.

The State Harbor Board, Mobile, Ala., is planning to spend about $500,000 for docks and piers at Mobile.

New Hanna Combination Yoke Riveting and Punching Machine

The Vulcan Engineering Sales Company, Chicago, Ill., has placed on the market a new Hanna combination yoke riveting and punching machine, manufactured by the Hanna Engineering Works, Chicago, which is particularly adapted to the punching of bent ship channels. An auxiliary dash pot mechanism absorbs the shock after the punch has passed through the plate. The advantages of the suspension arrangement shown in the illustration are apparent.

In the driving mechanism of the machine the toggles, levers and guide links are combined to give the large opening of the toggle joint movement with a gradual increase in the amount of pressure applied until the desired amount is secured.



Combined Yoke Riveting and Punching Machine, Showing Method of Suspension

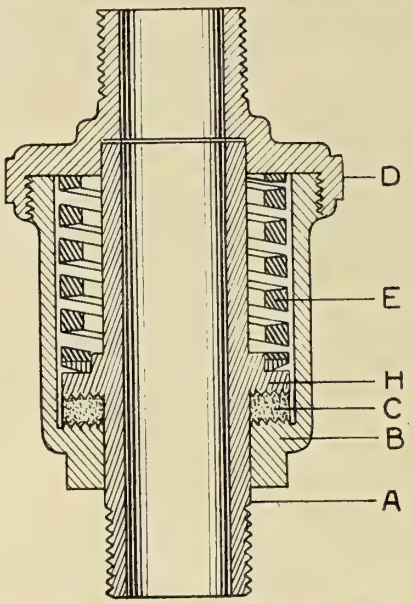
This is followed by a simple lever movement through a considerable space under approximately the maximum pressure of the machine. As was the case with the earlier machine, the toggle action takes place in the period when the piston is making the first part of its travel, the die traveling through a large portion of its stroke at the same time. During the time required for the remainder of the piston travel, the die completes its stroke. It is maintained that the amount of piston travel is enough to eliminate any uncertainty regarding the pressure applied to the rivet. The change in the action of the mechanism from that of a toggle to that of a lever is accomplished automatically without a critical point. The relatively large space through which the rated maximum pressure is exerted, it is emphasized, does away with the necessity for adjustment after the machine has been set for a certain length of rivet and thickness of plate to take care of ordinary variations in the length of the rivet, the size of the hole or the thickness of the plate.

As a predetermined pressure is applied to the rivet at each blow, it is pointed out that it is unnecessary to strike a rivet more than once. The slow movement of the die, while the lever action is taking place, is relied upon to give the metal in the rivet time to flow and fill the hole, as well as providing an opportunity for the rivet to set prior to the releasing of the pressure on the return stroke of the die.

Steel castings are used for the frame, main lever, guide links, toggles, plunger and piston rod heads, and cast iron for the main frame bushings and parts of the cylinder. The lower toggle and the die holder and screw, dies and piston rod are made of high carbon steel.

Knudsen Packless Swing Joints

The Knudsen packless swing joint, illustrated, which is manufactured by the Universal Valve Company, Chicago, Ill., is specially designed to meet the needs of a flexible steam line or for use with high pressure gas, oil, water and air lines. As shown by the cross section of the joint, the hollow cylinder *A*



Section Through Packless Swing Joint

revolves in the body *B*, bearing on babbitt ring *C*. The cap *D*, screwed down against spring *E*, keeps the revolving shoulder *H* pressed tight against babbitt ring *C*. The shoulder *H*, with several sets of concentric grooved rings, makes a series of ground joints in the babbitt ring *C*. As the spring *E* is made of cast iron and has no temper, heat cannot change it, therefore the pressure of the spring against cap *D* and shoulder *H* is constant.

List of Merchant Vessels of United States

The forty-eighth annual list of the merchant vessels of the United States, with their official numbers and signal letters, together with lists of vessels belonging to the United States Government and their distinguishing signals, has been issued by the Bureau of Navigation, with the records brought up to the close of the fiscal year 1916. It is a bound volume of 484 pages, and the various divisions are as follows: Sailing vessels alphabetically arranged; steam vessels similarly arranged; motor vessels; unrigged vessels; index to compound names; loss of American ships and list of vessels of the United States measured under Panama Canal rules; Government ships; names of vessels changed from July 1 to November 30, 1916; official numbers of vessels changed from July 1 to December 31, 1916; American ships of 100 gross tons and over reported as sold to aliens, July 1 to December 31, 1916.

Under the section relating to Government vessels are the following subdivisions: United States Navy; United States Army (including lists of Quartermaster Corps, Engineer Corps, and Ordnance Department); Treasury Department (including lists for Coast Guard and Public Health Service); Department of Commerce (including lists for Bureau of Lighthouses, Coast and Geodetic Survey, Bureau of Fisheries, and Bureau of Navigation); Department of Labor (Bureau of Immigration); Interior Department (Reclamation Service), and Panama Canal or Panama Railroad Company.

The information relating to merchant vessels includes official number, signal letters, rig, name, tonnage, register dimensions, service (of steam and motor vessels), crew, indicated horsepower, year and place of building ,and home port.

Copies of this publication may be obtained at 75 cents each from the Superintendent of Documents, Government Pirnting Office, Washington, D. C.

Joint Banquet of Mare Island and Golden Gate Branches of American Society of Marine Draftsmen, Palace Hotel, San Francisco, Cal., January 20

Joint Banquet of the Mare Island and Golden Gate Branches of the American Society of Marine Draftsmen

Forty-one members of the Mare Island branch of the American Society of Marine Draftsmen and thirty-four members of the Golden Gate branch of this national society attended a joint banquet held at the Palace Hotel, San Francisco, Cal., on January 20. Outside entertainers served to keep the minds of the draftsmen off the menu between courses, while the banquet was followed by a number of speeches dealing with various marine subjects.

The American Society of Marine Draftsmen is now composed of nineteen branches, three of which are located on the Pacific Coast. The Pacific Coast branches are the Mare Island, Puget Sound and Golden Gate, and were received into the society in the order named. Shortly after the Golden Gate branch came into existence a joint banquet, or get-together meeting was proposed by the Mare Island branch, so that members of the society around San Francisco bay could get better acquainted. The result was the very successful joint banquet of January 20.

Change of Address.—The New York office of the New York Shipbuilding Corporation, Camden, N. J., formerly at 50 Church street, has been changed to 120 Broadway, New York City. Mr. Edward B. Stadtler is New York agent for this company.

The steamship *Mielero*, the last of three boats being built by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Cuba Distilling Company, was launched on January 23 and christened by Mrs. Frances F. Rubens, wife of the president of the Cuba Distilling Company.

It is reported that a Japanese shipbuilding firm building stock boats on speculation has sold seventeen of them to British owners for delivery within the next six months. The tonnage involved is stated at 159,000 tons deadweight, the transaction being completed at a rate of about $215 a ton or more than $30,000,000 in the aggregate.

PERSONAL

James Swan, assistant to the president, New York Shipbuilding Corporation, Camden, N. J., has been appointed manager of the reorganized plant of the Herreshof Manufacturing Company, Bristol, R. I.

J. B. Weaver, formerly connected with the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been appointed vice-president and general manager of the Harlan & Hollingsworth Corporation, Wilmington, Del., succeeding Persifor Frazer, resigned.

Henry H. Schulze, for thirteen years chief estimator of the Fore River Shipbuilding Corporation, Quincy, Mass., was appointed on January 30 auditor of the corporation.

James F. Paige, formerly assistant superintendent of the Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed general manager of the Port Arthur Shipbuilding Company, Port Arthur, Ontario. Mr. Paige was with the Fore River Shipbuilding Corporation for thirteen years, and had charge of the official trials of all vessels built at the yard during that time.

C. W. Wiley, president and manager of the Seattle Construction and Dry Dock Company, Seattle, Wash., has been appointed agent for the Todd Dry Dock & Construction Company, New York, which is erecting a shipbuilding plant in Tacoma, Wash.

H. Burchard Taylor, secretary and treasurer of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has been elected vice-president, succeeding E. S. Cramp, and also a director, succeeding S. L. Hine of New York.

W. S. Rogers has resigned as president of the Bantam Anti-Friction Company, Bantam, Conn., and has been succeeded by Miss Nellie F. Scott, formerly secretary and treasurer of the company. Miss Scott also becomes general manager. Miss Ruth Edwards has been made treasurer. L. J. Nickerson has retired as vice-president; Henry Edwards becomes vice-president, and C. B. Heath, secretary. Mr. Rogers will retain the position as chairman of the board of directors and act in an advisory capacity.

James Terry, president Terry Steam Turbine Company, Hartford, Conn., died at Saranac Lake, N. Y., on February 3, aged forty-four years. Mr. Terry was graduated from the Sheffield Scientific School, Yale University, in 1895. He was a son of the late Mr. E. C. Terry, the inventor of the Terry turbine, who founded the present company in 1906.

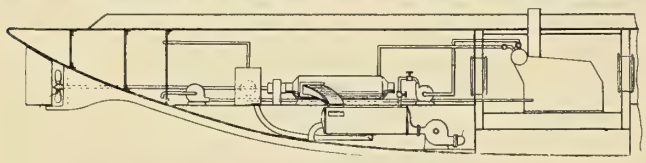
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,190,211. MOTIVE POWER FOR SUBMARINE BOATS. JOSEPH BARRAJA-FRAUENFELDER, OF BRIDGEPORT, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

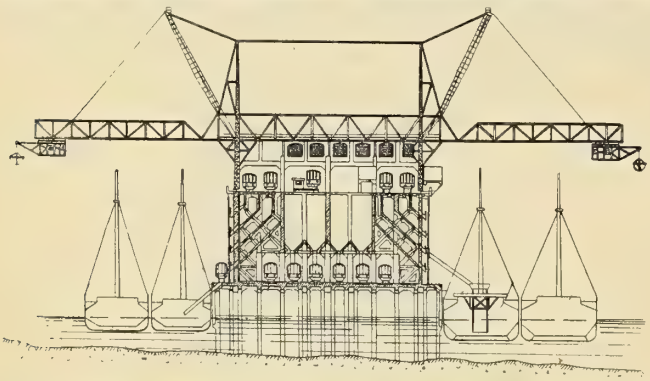
Claim 1.—In a submarine boat, a steam generating plant, a motor connected with said plant, and a condenser independently connected with said steam generating plant and with the exhaust of said motor, a valve for closing communication between said generating plant and said con-



denser, and means interposed between said generating plant and condenser for drawing the steam and hot water from said generating plant into said condenser when said valve is opened, to rapidly reduce the temperature of the generating plant, said condenser thereby serving as a cooler for the steam and hot water drawn from the generating plant and as a condenser for condensing the exhaust steam from the motor, substantially as and for the purpose specified. Five claims.

1,190,822. MEANS FOR LOADING AND UNLOADING MERCHANDISE. ALEXANDRE VANDEVELDE, OF BRUSSELS, BELGIUM.

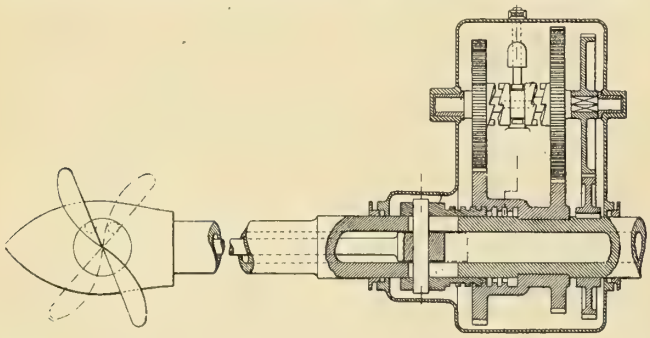
Claim 1.—A hopper comprising a plurality of similarly formed compartments, each of such compartments comprising an inclined portion



and an upright portion, the inclined portions having a superposed disposition and gradually increasing in length from top to bottom, and the upright portions having a lateral arrangement and gradually increasing in depth. Fifteen claims.

1,190,328. ADJUSTING DEVICE FOR REVERSIBLE SCREW PROPELLERS. CESARE SACERDOTI, OF GENOA, ITALY, ASSIGNOR TO SOCIETA ANONIMA ITALIANA GIO. ANSALDO & C., OF GENOA, ITALY.

Claim.—An adjusting device for reversible screw propellers comprising, in combination, a casing containing oil, a hollow driving shaft and an operating lever extending from said casing, the said lever being adapted to operate, at a distance, a reversible screw propeller with rotary blades by deriving the necessary power from the hollow driving shaft, two diametrically opposed slots in said hollow shaft, a cross rod passing

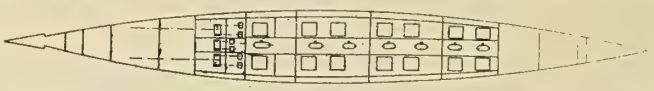


through them so as to protrude, a blade operating rod sliding in the bore of the driving shaft, said cross-rod being fixed to the end of the blade operating rod, and fast with a slidable screw threaded sleeve engaging with a nut loosely mounted on the driving shaft, but prevented by stops from being shifted axially, the said nut being adapted to rotate faster or slower with regard to the driving shaft by two pairs of gears two of which latter are fast with the nut, and the other two of which are loosely mounted on a countershaft receiving its movement from the driving shaft by a couple of gears respectively keyed on the driving shaft and countershaft, the loose gears being adapted to be made fast with the said countershaft by a double tooth clutch.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

13,030/15. "IMPROVEMENTS IN OR RELATING TO THE CONSTRUCTION OF SHIPS." J. REID, OF CORONATION HOUSE, 4, LLOYDS AVENUE, IN THE CITY OF LONDON, NAVAL ARCHITECT AND MARINE ENGINEER.

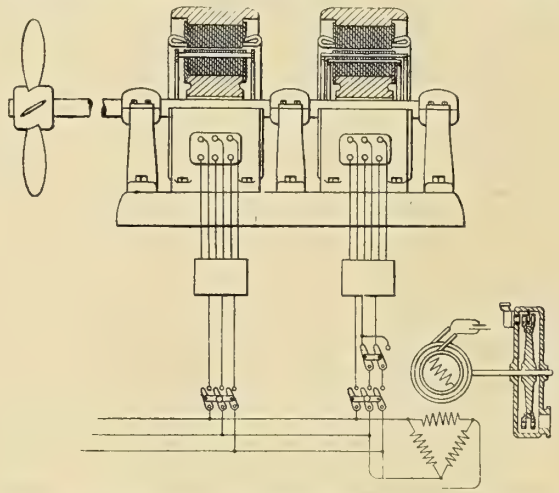
Recent disasters to large ships, such as liners and battleships, point to the necessity of a radical alteration in the internal subdivision of these ships. At present the engine and boiler spaces invariably occupy the most buoyant portions of the ship's structure with the disposition of the machinery extending considerably into the wings of the boat and involving very large open compartments free from or inadequately protected by transverse or longitudinal bulkheads. The result of such



arrangement is, that when a large ship is seriously damaged by collision, stranding, torpedoing, or the like, not only is there great risk that the largest compartments containing the essential elements for the ship's propulsion will be rapidly filled with water, but also that the whole power of the ship, on which its very existence depends, may be drowned out and the possibility of foundering becomes a certainty. This is actually what happened in the case of the liners *Titanic, Empress of Ireland* and *Lusitania,* and, as regards warships, in many of the ships which have recently been sunk by mines and torpedoes. According to this invention, in order to obtain the increased safety desired, the hull is so subdivided as to greatly increase, while reducing in size, the number of watertight compartments, and the power generating plant is so subdivided that instead of being grouped as at present into relatively large compartments extending to the ship's walls, they are spread to the largest possible extent lengthwise of the ship and everywhere separate from the outer walls of the ship by an intermediate wing space.

12,444/15. "IMPROVEMENTS IN AND RELATING TO SYSTEMS OF ELECTRIC SHIP PROPULSION." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, OF 83, CANNON STREET, LONDON, E. C., ELECTRICAL ENGINEERS AND MANUFACTURERS.

The system of propulsion comprises a suitably driven alternating current generator supplying energy to a pair of induction motors having their rotors mounted on the same propeller shaft. One of the motors has a short circuited secondary winding of low resistance, and may if desired have a primary winding adapted to produce primary magnetic fields of two different pole numbers, while the other motor has a primary winding adapted to produce primary magnetic fields of two different



pole numbers, and preferably is provided with means whereby the secondary resistance losses are increased when the connections for reversal are made. The method of operating such a system consists in employing both motors for running the ship at full speed ahead, and employing one motor alone with increased torque, obtained by lowering the speed ratio of this motor with respect to the frequency of the source of energy supply, for reversing the direction of motion of the ship. Where high economy at cruising speeds is desired, the motor having the short-circuited, low-resistance secondary winding is adapted for pole-changing and is used alone with its primary winding then connected for its low-speed pole number.

101,438/16. "IMPROVEMENTS IN ANTI-ROLLING DEVICES FOR SHIPS." J. ORR, JR., OF GLENLEA, PORT GLASGOW, RENFREWSHIRE, MARINE ENGINEER DRAFTSMAN.

The subject of this invention is an improvement in or modification of the invention described in the specification of letters patent No. 20,711, of 1914. The present invention contemplates, in lieu of the solenoid-operated mechanism therein described, the employment of an electric motor adapted to control the movements of the buoyant structure, such electric motor being supplied with electrical energy through a switch which is adapted to be actuated directly or indirectly by movement of a pendulum. As preferably arranged, the electric motor is situated above the water compartment and is connected by screw or other gearing to an upwardly extending bracket fitted to the buoyant structure.

17,489/15. "IMPROVEMENTS IN STOCKLESS ANCHORS." A. ROOKE, OF 16, VALE STREET, AMBLECOTE, NEAR STOURBRIDGE, ENGINEER.

This invention refers to stockless anchors, which have the flukes, arms, and shank box formed in one, with the end of the shank pivoted in the shank box, and the invention consists essentially in forging these parts of a stockless anchor in a single piece of steel.

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Twentieth Anniversary of Marine Engineering

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BY H. L. ALDRICH, PUBLISHER

IN April, 1897, MARINE ENGINEERING made its bow to the shipbuilding and shipowning interests of the country. Evidently this bow made an impression, for among other acknowledgments was one from a fellow publisher who welcomed us in these words: "Another marine publication, known as MARINE ENGINEERING, has made its appearance and we are supposed to welcome it. We do welcome it, just as a passenger who has squeezed his way into a crowded street car welcomes the next passenger who pushes in behind him." It may be said in passing that both the editor who made this acknowledgment and his publication departed from this life some years ago.

The year 1897 held out excellent promises for shipbuilding, as the so-called Spanish War caused an increasing demand for vessels, and during that year, and more especially in the four or five years following, shipbuilders were reasonably busy. Then followed years of dry times, during which the output of American shipyards varied from 636,793 tons in 1901 to 150,866 tons in 1908, reached 506,236 tons in 1912 and dropped to 286,878 tons in 1914. To-day the tonnage under construction exceeds two millions.

No branch of engineering has been so dependent upon Congressional action as shipbuilding, and never has a journalistic venture had such visions of prosperity held out to it only to have them jerked away, when just within grasp, as has MARINE ENGINEERING. Since 1897, each President of the United States in turn has in vain urged Congress to do something for the promotion and upbuilding of the American merchant marine. Instead of taking such action, it seems to have been the desire of each government in Washington to put some new burden on the operating of vessels, particularly in the foreign trade, but it remained for the present administration to put the strangling grip on the operating of vessels, by placing on the statute books the so-called Seaman's Law. In these war times anything that floats can earn big freight money, but when competition of the seas is again keen, probably no American ship can afford to enter the foreign trade unless the Seaman's Law is radically modified.

Since 1897 many old shipyards have been obliged to give up the struggle and go out of business. Until recently, in all these years, only two or three new concerns have been established. But for the fact that many of the largest yards had facilities for doing work other than shipbuilding, to keep alive, scarcely one of them could possibly have survived the long dry spell.

Among publications in the marine field the mortality record has been even greater than among the shipyards. The shipyards had an excuse for living, but the publications did not.

MARINE ENGINEERING was founded for a real purpose; namely, to give its readers the very best articles that the field afforded and to illustrate them thoroughly. Even in the years when a large proportion of the country's shipbuilding facilities lay idle, we continued to keep our editorial pages up to their highest standard of quality.

So certain were we of the correctness of our foundation plans, that we felt sure of the support of our advertisers. We charged more for a given number of inches of space for twelve insertions a year than any of our contemporaries charged for fifty-two insertions. We thrived in greater proportion than the volume of shipbuilding business warranted, while several of our contemporaries went to the graveyard of purposeless efforts. To-day we have represented in our advertising pages fifteen advertisers whose original contracts date back to 1897, and as many more which date to 1898.

On account of the war, American shipbuilders have been flooded with orders. To-day they are running 100 percent capacity and apparently cannot fail to keep up to this maximum capacity for many years to come. Repairing and replacing the 50,000,000 gross tons of the world's merchant marine existing July, 1914, will require many years of work. Evidently, therefore, investors in shipbuilding plants will at last reap profits from their investments after waiting twenty or more years for them.

During the years 1897 to 1906, shipbuilding in Great Britain was thriving, and yet, with the United Kingdom the greatest shipbuilding nation in the world, there was no publication published there devoted to the interests of the industry that compared in any way, in quality or appearance, with MARINE ENGINEERING. Therefore, in July, 1906, we started an English edition. It was the same as the American edition and published practically simultaneously in London with the American edition in New York. The only difference was in the cover.

The same high purposes which have made MARINE ENGINEERING the one great publication in the marine field will not be varied from in the future. We shall continue to make it the one and only source of information regarding engineering developments in the field. In other words, we shall continue to keep it in a distinct class by itself, as it always has been.

It is because of this policy that we now have a paid circulation averaging many subscribers per shipyard and reaching most of the steamship and steamboat companies. When the Audit Bureau of Circulations was organized, so as to have a guarantee of truthful circulation statements made by expert accountants, Marine Engineering was one of the first publications to apply for and to secure membership.

In another respect, the writer feels very proud of the position this publication has taken with its advertisers. Instead of falling into the almost universal custom of publishing anything in the editorial pages that advertisers or others asked for; of paying commissions and discounts and in all sorts of hidden ways charging various advertisers different prices and giving them preferential consideration, we have made the one ironclad rule, to treat every man exactly the same. Every advertiser has the same rate to the cent and is entitled to the same discounts; we pay no commissions nor do we attempt in any other way to "put it over" on any unsuspecting advertiser. In other words, every advertiser in Marine Engineering is assured of a "square deal."

Progress in Marine Engineering

FIVE years ago, when Maring Engineering commemorated its fifteenth anniversary, attention was called to the rapid progress that had taken place in the development of the science of marine engineering. At that time it was obvious that the period was one of transition and elimination. So many new developments were in the stage of experiment and trial that it was impossible to draw any definite conclusions as to the course which immediate developments would follow. With the increased size of ships and keen commercial competition, economy and efficiency were sought in every possible direction.

Then, as now, the greatest possibilities of securing marked gains in the thermal efficiency of propelling machinery seemed to lie in the perfection of the Diesel type of oil engine. With this goal in view engine builders, especially in Europe, spent vast sums of money in developing this type of machinery. The result was a great variety of designs of both two and four cycle engines. Initial successes in the workshops led to numerous installations—some of comparatively large size—in merchant vessels, but for every successful installation there were scores of failures, due either to defective design or workmanship or faulty installation and operation, and shipowners looked upon the new departure with distrust. At the present time, however, in spite of the serious setback which progress in this line suffered with the outbreak of war, sufficient experience has been gained so that early difficulties have been overcome and several types of Diesel engines are now being adopted with marked success on medium-sized cargo boats. With the return of peace this line of development will undoubtedly receive a new impetus, especially as the reliability of the improved machinery becomes better known.

In the development of steam machinery recent years have brought the successful application of the steam turbine to the propulsion of slow speed cargo boats. This has been accomplished by the adoption of geared turbine units wherein the power developed by highly efficient turbines operating at high speeds is transmitted with practically negligible losses through mechanical gearing to the slow turning propeller shaft. Various arrangements of high and low pressure turbines actuating single or twin screws have been adopted and in some instances the steam has been generated in oil-fired watertube boilers. The economy of such installations has been very marked. Not only has the consumption of fuel been reduced as compared with similar ships driven by reciprocating engines, but savings in the maintenance and upkeep are also possible. With the facilities now available for the production of this type of propelling machinery its widespread adoption in all classes of vessels is assured.

In high speed naval vessels of large power the most notable development of recent years has been the adoption of electric drive. The trial installation of this type of propulsion in a 7,000 horsepower naval collier proved so satisfactory that the navy department has not hesitated to adopt it on all recent battleships and the new battle cruisers. As none of these ships is as yet completed, the result of this policy remains to be determined.

Sea Power

TWO decades ago the United States became involved in a war in which our new navy of armored steel warships was put to its first test. At that time our navy was pitted against a foe whose naval strength and efficiency were far inferior to ours and the result was quickly decided. That brief struggle, however, in spite of the spectacular success achieved by our naval forces, disclosed in no uncertain manner the danger of unpreparedness, the value of naval strength and the lines along which naval efficiency should be sought.

To-day, with the country on the verge of entering the gigantic struggle in which the land and naval forces of the strongest nations in the world have been engaged for over two and one-half years, the first responsibilities will again fall upon our naval forces. How successfully these responsibilities can be borne depends upon how faithfully the efficiency of the navy and the maritime resources of the nation have been developed. Just as the strength and efficiency of a chain are determined by its weakest link, so the efficiency of the navy depends not only upon the strength and fitness of every branch of its intricate organization, but also upon the aid and support which it can derive from the maritime and shipbuilding resources of the country.

Must failure and humiliation be suffered in a great national crisis to teach this nation the folly of its past neglect adequately to foster its maritime resources and develop and maintain a position on the high seas commensurate with its power?

Marine Terminal Engineering

TWENTY years ago, when Marine Engineering was founded, it would have been impossible for anyone in the United States or in Europe to have written or even conceived such a paper as that given in this issue on "The Terminal Shed and Warehouse."

Some eighteen years ago Dr. Elmer L. Corthell, the late president of the American Society of Civil Engineers, then chief engineer of the Argentine Republic, sent two engineers to visit the principal ports of Europe to ascertain what was the standard practice as to the port development, design and equipment. They returned with the statement that there was no advanced, scientific practice common to many ports, but that each was proceeding according to the individual ideas of its own engineers.

To-day there is a wonderful similarity in plan, equipment, facilities and methods of operation at all foreign

terminals. The best has survived, and this best for the new American mercantile marine is now being adopted in the new port developments in the United States.

Marine terminal engineering is now as well known as the other branches of engineering and has taken its proper place. As a result, a modern marine terminal is designed along scientific lines, based upon engineering data now available from the world's ports, and combines the best features that have been developed in the leading ports throughout the world.

Open vs. Closed Feed Water Heaters

BY LUTHER D. LOVEKIN*

Notwithstanding the fact that the makers of open feed water heaters have been claiming every advantage over the closed feed water heaters, the question of heat transmission is one that is hardly understood by many of the users of this apparatus. It will be evident to anyone that if a tank is filled with water and exhaust steam led directly into said tank, the entire heat contents of the steam will be absorbed by the water, and the only losses in the open type of heater are, therefore, radiation and loss of vapor. The open heater has the great disadvantage, however, that any oil that may be contained in the exhaust steam mixes with the feed water, and, therefore, requires a thorough filtering. Several types of open heaters are made that thoroughly filter the oil.

Thermal Efficiency

In the closed type of feed water heaters the question of efficiency is one that is hardly understood by most users of feed water heaters, and, in fact, engineers themselves have made many statements which clearly prove a lack of knowledge of the subject of heat transmission. As a matter of fact, the efficiency of a closed feed water heater must be the same as an open feed water heater, providing proper attention is given to insulation and the recovery of the heat from the drains, for the reason that every type of a closed heater must be 100 percent efficient less the amount lost by radiation, if the heat from the drain is recovered by leading the same to a properly insulated feed tank. It can readily be seen that neither heater has any advantage over the other, so far as thermal efficiency is concerned, providing the heaters are properly installed, while the closed heater has the great advantage of not allowing oil in the exhaust to mix with the feed water.

After making numerous tests on different types of feed water heaters and observing results in each particular case, and noting the British thermal unit output to be almost identical under each and every condition, it appears to me that the only question that interests the designer is the ability to design an apparatus with the least amount of surface possible, necessary for a given temperature rise and resistance, and this latter problem forms one of the most ineresting subjects in heat transmission.

From numerous experiments made on heat transmission we note that the question of material entering into the construction of a feed water heater is a negligible factor, as the use of copper, brass or iron tubes will show equally good results, for the reason that the heat transmission through various metals is so much higher than it is possible to obtain under actual service in feed water heaters. In a feed water heater the metals having the lowest conductivity are capable of transmitting heat to the water very much in excess of any known rates of heat transmission where steam is used to heat water. This explains the fact as to why an apparatus built with copper tubes has shown no greater transmission rates than an apparatus fitted with iron tubes, and locomotives fitted with copper tubes are good evamples of this very subject.

Very frequently mistakes are made in mentioning the word "efficiency" on account of one apparatus requiring much less surface than another, and while this is really a case of efficiency so far as the ability to design an apparatus with more or less heating surface is concerned, the user of this apparatus will get the same thermal efficiency from the output, no matter what kind of a feed water heater he uses, providing, as before stated, that the radiation losses are reduced to a minimum, the heat from the drains recovered, and the work on the pump is the same. So it can be seen from the above remarks that, so far as the efficiency of the coal pile is concerned, all heaters can be placed on the same basis when properly arranged.

Deciding Factors in Selection of Feed Water Heaters

What is interesting to the user, however, is the purchase price of the apparatus, the cost of pumping the water to the boilers, and, in many cases, space occupied and reduction of weight are important factors, and, in fact, very often the deciding factor in purchasing said apparatus. Another feature which must not be lost sight of is the cost of repairs or renewals. From this it will be apparent that the heater which occupies the least space, has the least weight and the least heating surface, should be the most profitable investment, both initially and for final upkeep, on account of the reduced replacement cost of tubes in the heater having the least surface. This, then, is where the real efficiency counts.

It is well known that many types of apparatus on the market are based on heat transmission rates as low as 200 British thermal units per square foot per degree average temperature difference, while apparatus has been produced that shows more than 1,000 British thermal units per square foot per degree average temperature difference, resulting in designs of feed water heaters having only one-quarter the surface of others and yet being capable of producing the same results. As a matter of fact, heaters have been built which have shown from tests as high at 1,250 British thermal units per square foot per degree average temperature difference, and 1,000 British thermal units per square foot per degree average temperature difference can readily be obtained in practice. It can, therefore, be seen what an interesting subject heat transmission really is, if we can only find time to make the investigations necessary—and surely every effort in this direction is well worth while.

Feed Heater Tubes

Until quite recently it was thought that in order to obtain high efficiency, which meant reduced size of feed water heater, as well as less cost, less weight, etc., it was necessary to use some special form of tube. With a view to ascertaining just what could be accomplished by the use of 5/8-inch condenser tube, I designed and built a feed-water heater and have had extensive tests made of the same under varying conditions which have proven conclusively that there is no object whatsoever in using other than the 5/8-inch condenser tubes (which can be purchased in any part of the world) and which are so easily renewed in case of repairs. In other words, if a feed water heater is properly designed, you can obtain the same temperature rise as can be obtained with any other form of heater under identically the same conditions; the heater will occupy less space, have less weight and less cost of renewals. This is something that the shipowner and the engineer are interested in.

* Chief Engineer, New York Shipbuilding Corporation, Camden, N. J.

LETTERS TO THE EDITOR

Development of Oil Tankers

In the comprehensive paper on the earlier stages of tank steamship construction, published in your March number, the one steamer, the construction of which is, and always has been, considered pivotal in the development of tank ships, is not mentioned. This is the German tank steamer *Glueckauf,* built in 1885 by Armstrong, Mitchell & Company, Newcastle, for the German-American Petroleum Company, of Hamburg, after plans of Mr. W. A. Riedemann, founder of this shipping line.

This ship contained all the essentials of modern tank steamship construction up to the time of the introduction of longitudinal framing and the shelter deck. It especially did away with an inner double skin, using the ship's hull as the tank walls. The vessel started on her first trip to New York in July, 1886. Up to 1893 she ran to the satisfaction of her owners, stranding in that year off Fire Island.

The turning out and putting in service of this ship was, however, not accomplished without a number of incidents, which in the light of present-day experience are not without a tinge of humor. In the first place Mr. Riedemann could not find a shipbuilding concern willing to undertake the work. Every one feared to spoil its reputation by a later mishap to the ship. Then English Lloyds, as well as Germanischer Lloyds, refused the classing. This was done by Bureau Veritas, the only society, by the way, which for a long time had any building rules of their own for building tank ships.

On completion of the ship no crew could be obtained for her for some time. After a brief period of service, however, it was found that the dangers emanating from oil vapors were not so unsurmountable as first thought. The shipping people at that time used to refer to this vessel not as to *Glueckauf* (Good Luck), but *Fliegauf* (Fly up), which expectation, however, she did not fulfill.

G. Schmitt,
Ship and Engine Surveyor to Germanischer Lloyd.
New York.

Reinforced Concrete Ships

The interesting article on the above subject in your January issue prompts me to discuss a few general principles for the benefit of those who refuse to consider the concrete ship as even a remote possibility.

It has been argued that, owing to the alternating nature of the stresses to which a ship's structure is subjected in heavy weather the structural material should be equally adapted, as is steel, to carry tensile or compressive loads. Hence, for equal strength, the reinforced concrete ship would have to have as much steel as the ordinary steel ship, the concrete being valueless in tension, so that the concrete would be just so much extra weight to decrease the carrying capacity of the vessel.

Those who argue as above, however, lose sight of the following facts:

1. The present steel ship does not show an efficient use of the structural materials. Rivet holes, for the attachment of framing to the shell and beams or bulkheads to decks, cut away from 10 to 25 percent of the strength of shell and deck plating. In a reinforced concrete ship it would appear quite feasible to make joints of the steel reinforcement with little or no loss of tensile strength. Furthermore, the steel ship has an excess of strength in certain parts, as a matter of constructional necessity or convenience, but which would not have to be provided in a reinforced concrete ship. In the latter, the bulk of the steel could be placed just where required, thereby effecting great economy in its use without affecting the strength of the structure.

2. The present steel ship must be constructed with a large excess of material to allow for future corrosion and give the vessel a reasonable life. Such excess would be unnecessary with the steel protected from corrosion, as in a reinforced concrete vessel.

The time will doubtless come when, owing to the exhaustion of good iron ore deposits, etc., the price of steel will increase to a point which will force its more economical use and accelerate the development of the concrete ship.

Meanwhile it appears that much remains to be done toward providing a form of concrete which will be suitable for the purpose, a concrete, say, of fibrous structure or containing fibrous material and possessing reasonable elasticity. This done, there would seem nothing ridiculous or chimerical about the idea of large concrete ships, with all their possibilities in the way of rapid and cheap construction.

T. L. E. Haug,
Alameda, Cal. Union Iron Works Company.

The Most Economical Speed of a Merchant Ship

In the July, 1916, number of Marine Engineering Mr. Thomas J. Rogers has contributed a very interesting article on "Economic Marine Propulsion." Concerning the merchant ships I cannot, however, agree to the view of Mr. Rogers, nor can I see that the formula calculated really gives the most economical rate possible for such ships.

The formula calculated by Mr. Rogers reads as follows:

$$R = \left[\frac{q}{2k}\right]^{1/3}$$

q being constant expenses in money per 24 hours.
k being the costs of coal in 24 hours at the rate of one revolution per minute.

The formula for R, then, should give the most economical rate possible.

In this formula regard is taken only of the expenses, and the formula postulates that economy will be the best possible when the expenses per revolution are minimized. But this economy is not always of interest to the shipowner, the point being to him that the difference between receipts and expenditures is made the greatest possible. Ordinarily speaking it can very well occur that an increase in working expenses can lead to a yet greater increase of income, the profit then getting a greater one, too.

Considering the conditions of a ship running in a fixed market the amount of freight this ship can earn in a certain period—for instance, one year—will depend upon the number of trips which the ship can run in a year. Assessing the amount of freight earned by each trip on the number of miles passed over, we can say that in this market exists a fixed amount of freight per mile to be earned by this ship.

In a certain period the amount of freight earned will then depend upon the number of miles passed over in this period. On the other hand there will be a multitude of expenses, the amount of which—in a year, for instance—will depend upon the number of trips run in the year. Such expenses are war insurance, freight insurance, harbor charges, etc.

Assessing these expenses for one trip on the number of miles passed over we can in the same way say that in

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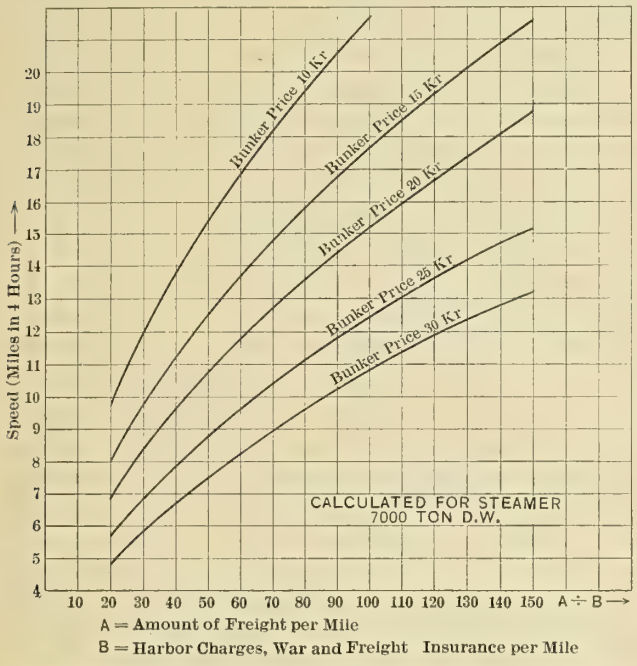
the market exists a fixed expense per mile for this ship and that in a fixed period—for instance, one year—the amount of these expenses will depend upon the number of miles passed over. Besides, we naturally have all constant expenses as hire, etc., the amount of which does not depend upon the number of trips run. The ship, then, must run at such a speed and pass over so many miles per hour that in a fixed period it earns the greatest amount possible of the difference existing in the market between receipts and expenditures.

The profit, however, will not always be the greatest when the ship is running at the highest possible speed, because the speed causes a certain consumption of coal,



Curves Showing Most Economical Speed of Steamer of 7,000 Tons D. W.

varying roughly with the cube of the speed. We can now set up the profit earned in 24 hours. The most economical speed will then be the speed making this profit a maximum.

In the calculations the letters have the following meaning:

A = amount of freight assessed per mile,
B = additional dues, as war insurance, freight insurance, harbor charges assessed per mile,
q = constant expenses per 24 hours,
k = cost of coal in 24 hours, the ship running 1 mile per hour,
F = real profit in 24 hours,
S = the number of miles *per hour* making the profit a maximum.

Assuming that the consumption of coal varies with the cube of the speed,

$$F = 24 \times S \times A \div [24 \times S \times B + q + kS^3]$$

If now:

$$\frac{dF}{dS} = 24 \times A \div 24 \times B \div 3\ k\ S^2$$

be placed $= O$. Then

$$S = \sqrt{\frac{8\,(A-B)}{k}}$$

and is the most economical speed possible.

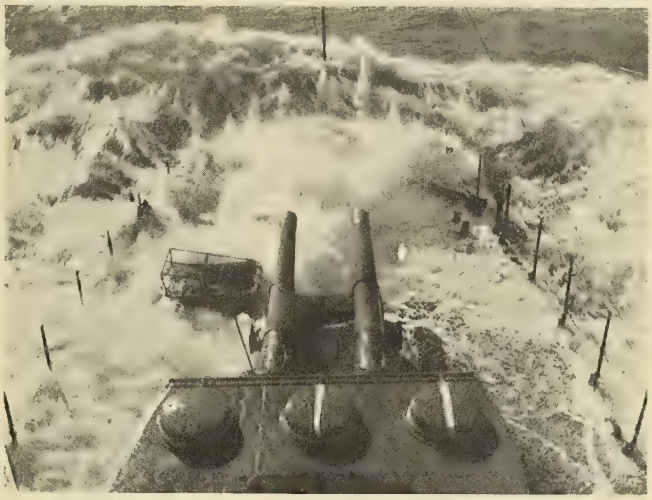
In the formula k can be calculated when we know the consumption of coal at a certain speed of the ship. If the consumption of coal of a ship varies with the speed according to another law than the cube, regard to this is only to be taken in the expression for the consumption and cost of coal. The formula presupposes that the machinery is not forced longer than this law, for the variation of coal consumption with speed really holds good. An eventual increase in the consumption of bunkers will cause a deduction in the deadweight, but in most cases this will have no great influence.

In the figure the formula is calculated for a ship of 7,000 tons deadweight for different bunker prices and the results are set in curves. If $A \div B$, for instance, is 30 and the bunker price is 15 Norwegian kroner, the most economical speed of this ship will be 9.7 miles in four hours.

Bergen, Norway. Francis Konow.

An Unusual Photograph

The accompanying photograph may be of interest to readers of Marine Engineering, as it was taken on board the United States monitor *Tallahassee*, while rounding



On Board the U. S. S. *Tallahassee* During a Recent Storm off Cape Hatteras

Cape Hatteras during a recent storm. As can be seen, heavy seas have complety submerged the forward decks of the vessel, and the picture gives some idea of the severe conditions encountered during the winter months by vessels off the Virginia capes.

L. E. Bordonaro, Electrician (Radio).
U. S. S. *Tallahassee*. U. S. Navy.

Propulsion of Moderate Sized Wooden Cargo Vessels

While the production of a great number of moderate-sized wooden cargo vessels to meet the present emergency is entirely feasible in the United States, the question of powering these ships is likely to present difficulties. There are very few builders of oil engines in sizes of from 200 to 500 horsepower in this country, and it is doubtful if a sufficient number of such engines could readily be obtained. There are, however, a great many manufacturers who are able to supply in a comparatively short time gasoline (petrol) or heavy oil engines of from 100 to 125 horsepower.

If a moderate-sized wooden cargo boat requires 500 horsepower, four engines of 125 horsepower could readily be obtained and arranged to drive a single shaft through reduction gears. With this system, if one of the engines breaks down, there would still remain three-quarters of the total power for driving the ship instead of a complete breakdown, as would be the case with one engine of 500 horsepower. Engineer.

The Revival of Our Merchant Marine*

Early Development and Subsequent Decline of the American Merchant Marine—The Commercial Crisis Now at Hand

BY GEORGE J. BALDWIN†

WHEN the first settlers reached the shores of New England they found before them forests and a soil not especially bountiful in its gifts to man. It was, therefore, natural for them to earn their living from the sea, and in doing this boats and shipping became necessary; for these the forests furnished the material, so that in those early days almost every man became familiar with the sea and with shipbuilding. He followed the industry from the cutting of the logs in the forest to the placing of them in the vessel by his own labor, for which he was paid by a part ownership in the vessel upon which he afterwards sailed. This produced a race of hardy sailors, skilled in ship construction and operation, intensely interested in their ventures because of personal ownership, which furnished every incentive for the utmost personal effort, and resulted logically in high efficiency.

Thus began the foreign trade of the United States, starting at the fisheries, transporting their products to the West Indies, to Great Britain and the Orient, then bringing back the products of those countries. By 1796 American tonnage was nearly 600,000 tons; 90 percent of our exports were carried in our own ships, and 94 percent of our imports brought back by them, a growth in shipping without a parallel in the history of the world. To preserve this growth we fought in 1812, and became the most successful maritime nation in the world's history. We all remember the history of those dashing clipper ships, the *Rainbow, Flying Cloud, Challenge, Northern Light,* and others, which enabled us to hold supremacy on the ocean highways until shortly before the Civil War.

Loss of American Maritime Supremacy

By this time, however, our people had spread inland. They were engaged in developing the tremendous resources of the country. The production of iron and steel in America was in its infancy, and while our people were gradually withdrawing from the sea, the age of steel and of steam enabled England to take her place upon it. While we could build ships of wood more cheaply than she could, wooden ships were doomed. England's rapidly developing industries in coal and iron enabled her to produce a cheaper cargo carrier than could be built in this country, and from that time until this her supremacy in the ocean trade of the world has been undisputed. This supremacy has permitted the construction of vessels in such large volume that individual shipbuilders have been able to specialize and to construct in large numbers a single type of vessel, bringing their costs lower than those of other nations.

We have learned the same lesson in other lines, notably in the manufacture of machine tools; that is, tools designed for the manufacture of locomotives, boilers, engines and all other kinds of metal work. We now make the cheapest and best machine tools in the world, and this is the foundation of our manufacturing industry. With these tools we have been able to lead the world in producing automobiles, sewing machines, watches and a thousand other specialized manufactures. To-day we owe our manufacturing position to our skill in the design of machine tools, the efficiency of their operation, and the volume of the product we are able to turn out by their use.

Remarkable Success on the Great Lakes

We have had one opportunity of specializing in ships. The traffic on the Great Lakes, protected by law, required that Americans should construct American ships to transport coal, ore and wheat, and because of this protected condition we have been able to produce upon the lakes cargo carriers moving freight at less cost per ton mile than any other agency anywhere else in the world.

No country produces steel, coal, copper and all of the various raw products entering into the manufacture of vessels more cheaply than we do. Our machine shops and technical industries have grown tremendously, our skill to-day in the manufacture of machine tools and other labor-saving machines surpasses that of any other nation, and our inventive capacity ranks equally high. We are generously equipped, ready to begin our struggle for our place upon the ocean. The volume of our foreign trade, already immense, is growing, and will continue to do so. We are becoming more and more a manufacturing nation and must amplify our trade with the newer countries still in the agricultural period of development; and just at this time in our commercial history, when we stand fully prepared to do this, a flood of wealth is accidentally poured into our hands as one of the results of the European war. Our surplus manufactured product is being delivered to these nations, and we are to-day extending credit to them in lieu of the cash they are unable to pay. It is imperative that we find means of transporting our goods in our own vessels, and not in vessels owned and operated by our competitors.

Crisis in American Commercial History

We have arrived at a crisis in our commercial history; if we fail to take advantage of it, the country cannot continue its present progress, but if we grasp it our trade will be immeasurably extended. What better course can we pursue than to devote some of our new capital to the construction of merchant ships, so that we may again carry over 90 percent of our foreign trade in American bottoms? We shall be prepared for any contingency which may befall us, when to this merchant fleet we have added an armed navy capable of protecting it.

The people along our coasts have been more or less awake to this need, but those of the interior have only just begun to think of it. Now, however, the acute scarcity of ocean tonnage and the high costs of ocean transportation consequent upon it have been brought home to everyone, and I believe public opinion is awakening.

England is now engaged in nationalizing her entire shipping for the purpose of using it, not for competition between British subjects, but as a unified instrument directed by one central authority and operated for the benefit of the nation. Can we compete with this unless we are permitted to follow along lines of concentration instead

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* From *The Americas.*

† Senior vice-president of the American International Corporation, president of the Pacific Mail Steamship Company, and chairman of the Board of the New York Shipbuilding Corporation.

of unlimited competition between ourselves? Japan is taking possession of the trade of the Pacific Ocean. She subsidizes her shipbuilders and her shipping companies, and is to-day in control of the bulk of the traffic on the Pacific. Norway has been concentrating the enormous profits earned by her vessels, and a large proportion of the merchant shipping now under construction in American yards is being built with this money for her benefit.

The cost of ship construction to-day in the United States is no higher than in competing maritime nations, but this is an abnormal condition of which we must take present advantage, and during this period we must learn to construct our ships as cheaply as those of England, Germany, Scandinavia and Japan. To this end our colleges should co-operate. Beginning with the training of our young men during their undergraduate courses, we must coördinate this theoretical education with practical work in our shipyards, so that on graduation our naval architects and marine engineers will be thoroughly qualified for their part in this work. Our shipbuilding corporations must coöperate with the schools and with each other in order that all yards may be able to reduce their cost of construction. To realize the greatest advantage to the nation, our laws should be so modified as to permit the most economical operation of the ships we construct. Our bankers should teach the people the necessity and wisdom of investing in our merchant marine, and finally, the power of the United States Government should be added to our other agencies in order to encourage in the fullest possible manner the growth of our ocean transportation system, so vital to the needs of this country.

If we do these things, our future is assured, but if we fail in one of them we shall lose our opportunity, perhaps never again to secure it.

Shipping to Latin America*

1916's Progress and 1917's Promise — Remarkable Increase in American Ships

BY A. EUGENE BOLLES †

BECAUSE of the difficulty experienced in shipping goods to Latin America during the early part of 1916, many American firms discontinued attempts to secure Latin American business because of the fear that they would be unable to get their goods into the buyers' hands. So many inquiries came to our office for information regarding the shipping situation that we have made this survey in the hope and belief that sufficient facts could be assembled to give satisfactory answers to the questions most frequently asked, viz.:

1. Have shipping facilities to Latin America improved during 1916?
2. Is further improvement promised for 1917?
3. Is a reduction of freight rates likely during 1917?

To secure this information a canvass has been made of every port from Boston to Seattle, every steamship company with lines to Latin American ports, the various Federal departments dealing with such matters, a number of large shippers, the marine periodicals, and several other organizations in more or less close touch with the situation.

What the Ports Are Doing

New York.—A canvass of seventeen steamship companies running on regular schedule to Central and South America and the West Indies brought out in all cases the claim that they were handling all offerings of freight billed to ports regularly reached and that they were ready to increase their tonnage as soon as the demand would warrant it.

Only two companies reported additions to tonnage during the past year, but nine have arranged to restore former service or to add new boats to the number of thirty—one or more during 1917. Of the latter, four freight and passenger boats of 8,000 to 10,000 tons and two smaller boats will be put on about July 1 by Grace & Company, to run direct from New York to West Coast ports via the Canal, making the trip to Callao in eleven days, a saving of seven days over former schedules. Five boats are being built in England for the United Fruit Company, and are to be delivered in the early summer. This company expects to charter several additional boats.

Boston's steamship service to Latin America is practically nil, according to the Boston Chamber of Commerce. There are no direct lines, but many arrivals from Argentina, Uruguay and Chile, practically all of these ships going to New York for return cargo.

Baltimore promises to make for itself an important place on the map as a port of shipping to Latin America. A $15,000,000 (£3,070,000) corporation promoted by local capitalists and fostered by the railroads entering that city, and the city government, will put on a line to South America as soon as equipment can be secured.

Charleston has no direct lines to Latin America, but the Southern Railroad is making of it an important port for coal shipments, a number of cargoes having gone from this port during 1916, and it is expected that the business will materially increase during 1917.

Mobile is planning extensive harbor improvements, and the Munson Line running out of this port to West Indies and River Plata ports has been up to capacity much of the time during the past year, has added two new boats to the Buenos Aires run, and at times has been compelled to put on extra boats from their tramp fleet. It is expected that the River Plata service will be increased to two boats a month during the present year.

The New Orleans Association of Commerce has made a canvass of the nine steamship companies running on regular schedule out of New Orleans to Mexico, Central American and West Indian ports, and reports considerable increase in tonnage during the past year; that all freight is being moved quickly, and that ship owners are prepared to add to the number of boats in service as fast as the demand warrants it.

Galveston.—The Commercial Association reports the reestablishment of one line to Mexican ports during 1916; that they have been handicapped in making further increases because of the scarcity of ships, and that they have

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* Read before the National Foreign Trade Council Convention at Pittsburg, January 26, 1916.

† Manager of Spanish edition of *World's Work Magazine.*

very definite plans for extensive steamer service to West Indies and Central America during 1917.

San Francisco's trade with Latin America during 1916 showed a large increase, according to the Chamber of Commerce, but all shipments were satisfactorily handled.

Seattle's service to Latin America has been materially reduced since the war began, there being at present only two lines running direct, one running monthly and one bi-monthly to West Coast ports.

Lines from South American Ports

In order to provide means for transporting their principal products to market, certain South American republics have by concession, charter, or other methods, aided in the establishment of lines to the United States during 1916. Ecuador, Peru and Brazil have been particularly active in this respect, and it was recently announced that a company with $12,500,000 (£2,560,000) capital had been organized in Chile to establish a line of steamers to the United States.

The Government's Figures

According to Commissioner Chamberlain, of the Bureau of Navigation, ship space available for carrying freight to South America has increased during 1916 50 percent over 1914. The total tonnage of ships cleared during the first ten months of 1914 amounted to 1,700,527 net tons, and during the same months of 1916, 2,516,300 net tons. Foreign tonnage has remained about stationary, the gain being almost wholly in American ships, which in the first period amounted to 171,433 net tons, and in the second period to 914,227 net tons, an increase of 433 percent. The total tonnage of American ships cleared for Argentine during this period of 1916 was nearly thirty times that of the first ten months of 1914; for Chile six times; for Brazil five times; the American tonnage cleared for Venezuela and Colombia doubled, while there were 66,169 net tons cleared for Uruguay against none at all in 1914.

Tonnage of ships for Mexico, Central America and the West Indies increased about 400,000 net tons during the two years, making the total tonnage to all Latin America 7,660,192 in the first ten months of 1914 and 8,840,866 during the same months of 1916.

The total tonnage of ships entered from Latin American ports showed a *decrease* during this period due to the fact that before the war ships from Europe carried cargoes to Latin American ports then proceeded in ballast to the United States, where they loaded cargoes for Europe, and that since the war this triangular trade has largely disappeared. The total decrease in tonnage amounted to 890,624 net tons, but the tonnage of American ships entered from Latin American ports *increased* 3,101,967 net tons, or 154 percent.

There is much in these figures to cheer the heart of the patriotic American who is hoping for the restoration of our merchant marine.

Comparing the first ten months of 1915 with the same months of 1916, an increase of 951,632 net tons clearing for Latin America is shown, of which 933,056 tons were American ships. While the total tonnage of ships entering from Latin America increased 1,098,460, that of American ships increased 1,226,923 net tons, foreign tonnage having decreased about 200,000 net tons.

Two years ago American ships made up 25 percent of the tonnage cleared for Latin America; now the Stars and Stripes wave over 58 percent of it.

Estimates for 1917

The Foreign Trade Department of the National City Bank estimates that the ships to be added to Latin American trade during 1917 will aggregate 300,000 tons. The information assembled to this survey, confirmed by the opinion of several well posted men, seems to indicate that the National City's figure is too conservative, and that the increase will approach close to a half million tons.

Whether the war ends in 1917 or not, there is every indication that a large number of boats other than those already mentioned will be added to Latin American service. Many shipowners engaged in European trade are free to admit that the risk of loss is becoming too great for profit, and well posted men look for the early withdrawal of many ships and their transfer to the safer waters of South American commerce. It is, of course, possible that the recent raid in South American waters may change this opinion to some extent, but it is believed that the shipowners will still prefer to face the few dangers of South American seas rather than the many risks involved in European trade.

On the other hand, the ending of the war will release over 16,000,000 tons of interned or commandeered ships and restore them to the peaceful channels of trade.

The New Shipping Board

The claim has been made repeatedly that the shipowners are awaiting to see what the new Federal Shipping Board is going to do, but persistent questioning has brought out the fact that what the new Board will or will not do is a matter of little interest to shipowners, and the remarkable increase of American ships would seem to confirm this. It is difficult, if not impossible, to find a shipowner in favor of the new law, and there is an increasing sentiment favoring shipping laws modeled after those of Norway, poviding for Federal aid in the form of bond issues guaranteed by the government.

The Question of Rates

Shipowners, like other humans, go where profits promise best. The big demand for bottoms and the excessive rate of insurance has pushed up the European rate and pulled up the rate to Latin America part way. The present rates to South American ports for a run twice as long as across the Atlantic are from 20 to 50 percent lower than the European rates.

Increased competition for South American freight, more boats bidding for business, can have but one perfectly natural result—lower rates. That such a situation is bound to arise in the early part of 1917 seems reasonable to believe, even if not inevitable. Competition for Latin American freight is increasing now and will continue to increase during 1917 by the addition of the half million tons already planned and the indefinite number of boats driven from European trade by the growing danger of destruction; while if the war should end, the release of one-third of the world's tonnage, now commandeered or interned, will naturally reduce the cost of shipping goods to something like a normal figure. The restoration of pre-war rates can hardly be expected, because if hostilities cease in 1917 the world will find itself from 6,000,000 to 10,000,000 tons short of the normal tonnage—about 12 to 15 percent of the total.

Taking the cold facts as they are given in the foregoing, it would seem that only one conclusion is possible, and that is that shippers to Latin America have been through the worst of their troubles, and that they can go full speed ahead with their efforts to become solidly established in the countries to the south with the reasonably safe assurance that by the time those efforts result in orders the goods can be delivered promptly and at a fair cost for shipping.

Review of the Progress of Marine Engineering During the Last Twenty-Year Period

Conditions in the Marine Field Twenty Years Ago Contrasted with Attainments of To-Day—Noteworthy Accomplishments of American Engineers

BY WILLIAM T. DONNELLY*

WHETHER twenty years or two decades in a human life is a long or a short period of time depends, as in other periods of history, upon the importance of the events transpiring within the period. Considered from this point of view the *twenty years* comprising the history of MARINE ENGINEERING is comparable to as many centuries of time in maritime history only slightly removed from it.

The space allotted to this review of progress during the period referred to is all too brief to convey even an outline of the important advance that has been made in every line of marine endeavor, and if the author shall have any success at all, it will only be by sketching in the background of twenty years ago and then superimposing upon it a picture of our attainments of to-day, leaving the readers to fill in the tremendous gap between, from their own contact and experience.

This will be more readily possible when we take into consideration the fact that most of the men prominent in marine engineering affairs twenty years ago are still with us to-day and taking leading parts, and I feel that there could be no better introduction to the review of this period than reference to a page from MARINE ENGINEERING of November, 1897. From the men mentioned there came the inspiration, encouragement and loyal support which have made an adequate record of the period possible. It would be a presumption to introduce a single one of them, and their names are entered here for record only. All honor to the men who led the way: Clement A. Griscom, W. F. Durand, Irving M. Scott, Lewis Nixon, Commodore Philip Hichborn, Commodore George W. Melville, H. T. Gause, Stevenson Taylor and Edward F. Gaskin.

FIRST HOLLAND SUBMARINE LAUNCHED IN 1897

In May, 1897, there was launched at the yard of Lewis Nixon the first Holland submarine. The success of this boat, together with others designed by John P. Holland, may be said to mark the first successful construction and operation of the submarine. It is worthy of note that at this time submarines were not included in the naval equipment of any of the nations of the world.

In June, 1897, there was given to the world the first account of the application of the steam turbine to marine propulsion, the application being made to an experimental boat, the *Turbinia,* with which a speed of 32.75 knots was obtained. This boat was built purely as an experimental craft by English engineers.

I find that the most notable launching of the year was that of the transatlantic liner *Kaiser Wilhelm der Grosse,* 648 feet in length, displacement 19,684 tons. This vessel broke the transatlantic record with a speed of 21.39 knots.

In 1898 we find the record of the launching of the first Lake submarine, the *Argonaut,* and early in the same year an account of the application of the gasoline (petrol) engine to a small launch. In the description of this boat the term motor boat is applied.

It was perhaps prophetic of the destruction of our own days that in February of this year the battleship *Maine* was destroyed by a mine in Havana Harbor. The Spanish War, which followed closely upon the destruction of the *Maine,* was the first actual test of modern naval vessels constructed in the United States, and the result was such as to add to our loyalty and increase our confidence in our marine designers and constructors, as well as the men behind the guns, not forgetting our equally loyal and efficient commanders.

DEVELOPMENTS IN NAVAL CRAFT

The twenty years' progress in marine arts, as applied to naval craft, has been mainly devoted to the perfection of well-known methods of construction and armament, with the enlargement of guns and a very considerable increase of range due to the advances in the metallurgy of steel, notably in the heat treatment and by the use of certain alloys developed through the use of metals, such as nickel, titanium, vanadium and tungsten, largely increasing the tensile strength and endurance. Perhaps the most marked advance was made in the matter of range finding and fire control, through which not only has the practical range been very much extended but the accuracy and rapidity of fire at all ranges have been vastly increased.

This period has also seen a very considerable modification in the propelling power, with a corresponding advance in cruising and maximum speed. The advent of the steam turbine, together with the ever-increasing size of battleships and cruisers, has made it possible to install power far beyond the wildest dream of twenty years ago, reaching its climax in present designs which contemplate the application of more than 180,000 horsepower to the propulsion of one vessel. The additional boiler power to furnish steam has been obtained largely by the substitution of oil in place of coal for fuel, with a consequent very large reduction in the space and weight required. It is worthy of particular notice that in this extreme application of power the use of electricity for the actual propulsion of warships is being considered for the first time.

HIGH SPEEDS DEVELOPED BY MOTOR BOATS

In December, 1898, the steam yacht *Ellide,* designed by Charles B. Mosher, made a speed record of 40 miles per hour. Both designer and yacht are still with us to-day. While the steam yacht still maintains a prominent place as the luxuriant summer home of Americans of great wealth the application of steam to pleasure craft has been far outshadowed by the development of the motor boat, which is generally understood to mean gasoline (petrol) as a source of power through its use in the internal combustion or gasoline (petrol) engine. By means of this application of power small boats upon the water have finally obtained a speed greater than 60 miles an hour, rivaling the classic express train rate, long considered the acme of all human transportation, and it would almost seem as if the motor boat of comparatively small size and high power was to win the "blue ribbon" of the sea for all

* Consulting engineer, 17 Battery Place, New York.

time by proving itself to be an adequate defense against that terror of the deep, the submarine.

At the beginning of this period wireless telegraphy was unheard of, while now it may be said to outrank in importance all other human means of communication and justly claim to be the most far-reaching and important life-saving device thus far developed in human history.

No phenomena of life make a stronger appeal than the flight of birds through the air and all history records the longing and ambition of man to conquer the atmosphere and join the birds in their flight. For more than four thousand years all the most courageous spirits who dared to attack this problem met only with failure and ridicule. How greatly we should, therefore, honor the men and the period in history that saw its final accomplishment. All praise and everlasting fame to the Wright brothers.

Significance of the Gyroscope

The burning of oil for fuel under marine boilers had hardly been thought of twenty years ago, the use of the Diesel engine for marine propulsion barely attempted, and the application of electricity to the propulsion of vessels was being derided as an economic absurdity. No reference to the accomplishments of this period would be complete without mention of the gyroscopic compass, that modern marvel of scientific accuracy and ingenuity, the one device which bids fair to supersede the lonely mariner's oldest and truest friend, the magnetic compass. The gyroscopic compass may well be described as one of the most important marine inventions over a period of more than three thousand years. It not only guides the mariner with vastly greater accuracy than the magnetic compass, but also serves to direct the submarine below the ocean surface, a task said to be entirely beyond the powers of the magnetic compass. A modified form of the gyroscope has been adapted to control the rolling of ships at sea and its perfection for this purpose may earn for it the title of the best friends of the landsman as well as of the mariner. Another modification has been adapted to control and steady the flying machine and the limit of its possibilities is not yet known. The name of Elmer A. Sperry will be associated with this achievement for all time.

When sufficient time has elapsed to enable future critics to obtain a clear and comprehensive view of this period, it is probable that the relative importance of the many notable discoveries and inventions referred to it will be very much modified. But certainly several of them will hold first place in the long list of important human accomplishments. Within this narrow period, embracing less than the active period of a single lifetime, there have been crowded the discovery and perfection of the means of navigation of the atmosphere surrounding the earth, the means of keeping in constant communication with vessels at sea over all the oceans of the globe, and the perfection of the means of navigation, both for war and for commerce, beneath the surface of the seas. As if to lend final emphasis to this last discovery, it would almost seem as if it was to be the last and final arbiter between the isolated groups of human beings hitherto known as nations, and that it may be *that final invention of man* as outlined by the prophetic imagination of Jules Vergne, which was to be so terrible as to make human conflict unbearable for all future time.

Twenty Years of Productivity

No more striking comparison can be made than in the relative importance to this country of marine construction at the beginning and at the end of this period. The opening of the period occurred at a time approximating the most active interior developments of the country, when all the energy and capital and resources of the nation were directed to the construction, development and reorganization of interior communication by means of railways, and for more than half the period under consideration a very small group of men, discouraged and alone, struggled on, laying the foundation and blazing the way for what we are now just beginning to realize as the most intense and crucial period of maritime activity in all human history.

Inland Waterway Transportation

Some reference should be made to the development of commerce and passenger transportation upon our inland waterways, more particularly as the advent of the application of steam power to navigation was commenced upon the waters of our own Hudson River little more than 100 years ago. The development of passenger transportation upon this river has brought into existence within the period referred to the largest and finest-equipped steamers designed solely for the transportation of passengers to be found anywhere in the world. In fact, they are so far in advance that they stand in a class by themselves and are the pride of all who have been privileged to journey on this historic waterway.

Great Lakes Shipping

Equally notable have been the developments on our inland waterways, particularly the system of Great Lakes on our northern boundary. Here we find the commerce and transportation of the great commodities, grain, ore and coal, exceeding that of any other area in the world, and the development of passenger traffic culminating in the Buffalo and Cleveland boats is equaled nowhere else. Many names could be mentioned within the period referred to with reference to this work, none, however, more representative than that of the engineer and designer we all know so well, Frank E. Kirby.

As a final word, this period opened rich in men of vision and genius at a time when the outlook for the future was dark and discouraging, with very little but tradition to be proud of in connection with the maritime situation in America. It closes with America leading the world in activity in all matters of maritime importance, and with the future brighter than the wildest dream ever conceived by the most heroic advocate of the American merchant marine. All honor to the past; all hail to the future!

The First Torpedo Boat Destroyer

Messrs. Yarrow & Company, Ltd., Scotstoun, was the first firm to propose to the British Government the construction of speedy vessels especially designed to counteract the class of torpedo boats then in existence. To the new design was given the name of torpedo boat destroyer.

The first of these was 180 feet long by 18 feet 6 inches beam, and obtained a speed of 26 knots. The second one, which was fitted with Yarrow tubulous boilers, obtained a speed of 27 knots. In 1894 a vessel 10 feet longer was built for the Russian Government, and was the first boat to obtain a speed of 30 knots. A larger boat, built in 1900, for the Japanese Government—over 220 feet long—obtained a speed of nearly 32 knots, and the next year a vessel was built for the Swedish Government which obtained 32½ knots.

Lately the size and speed of these vessels, with much improved internal arrangements and fighting power, have greatly increased, until 39 knots has become a practical speed and 40 knots or over is well within view.

The Development of Screw Propulsion During the Past Twenty Years

Chaos in Propeller Design Responsible for Many Absurdities — Scientific Investigation Brings Efficient Production of High Speeds

BY CAPT. C. W. DYSON, U. S. NAVY

FOR many years after the acceptance of the screw propeller for the propulsion of ships the knowledge concerning the laws governing the design and operation of this instrument was crude, and so little interest was taken in the problem by both owners and builders of vessels that no reliable data as to speeds of vessels and actual resistances overcome by the propeller at these speeds were available.

The problem was still further obscured by the fact that speeds of vessels and the powers required for these speeds were low, and therefore the variations in the projected area ratios required to cover the entire field necessary for these powers—and speeds—were very small.

In order to render greater assistance in holding back the growth of knowledge of the subject, the propeller designers varied the blade shapes as much as possible, there being nearly as many different shapes as there were men designing the propellers. Many of these designers were so confident that the particular feature favored was the principal controlling element in the delivering of high efficiency, that they applied for and were granted patents on these features, which to-day we know to be absurdities and which in place of increasing efficiency may have quite the opposite effect.

Possibility of Cavitation Foreseen by Barnaby as Early as 1888

In the year 1888 Mr. S. W. Barnaby stated as follows: "I think I may say that we who are engaged in designing and building torpedo boats and other fast vessels are doing pioneer work with the screw propeller, for we are among speeds which have not yet been attempted by the big ships, although they are coming close up behind us." The author proceeded to point out that one probable source of trouble in the future would arise from the fact that the velocity of the blade tips would increase as speeds increased, because the circumferential velocity of a propeller of given pitch-ratio, working at maximum efficiency, would be directly proportional to the designed speed of the ship, and he concluded by saying, "*It becomes an interesting question as to how fast the water can follow up the blades of a screw.* Perhaps on some future occasion we may have this point investigated. But whether there may or may not be difficulties ahead in this direction, the friction and resistance of the blades at these high velocities become a very serious consideration, and *it appears that it may become necessary, as the speed of vessels increases, to use screws of greater and greater pitch ratio, and to submit to reduced efficiencies in consequence.*"

This statement of Mr. Barnaby's constitutes a distinct prophecy concerning the phenomenon called "cavitation," which had undoubtedly been encountered many times antecedent to this prophecy but had not been recognized. Mr. Barnaby at this period, evidently labored under the impression that the phenomenon would be due to speed of ship and tip speed of the propeller, an impression which future experience completely dissipated.

The difficulties foreseen by Mr. Barnaby were not encountered in serious form until 1894, when they cropped out in the trials of the British destroyer *Daring*. The cure for the trouble was not, however, *increase in pitch-ratio,* as prophesied by him, but *increase in projected area ratio.* This method of preventing cavitation troubles was still further demonstrated on this side of the water by experience with the United States destroyers *Perry, Preble* and *Paul Jones,* where with propellers practically identical in all respects except that of projected area ratio the speed, power and revolutions at which cavitation was developed to a serious extent all increased as the projected area ratio increased, until in the case of the last-named vessel it was beyond the limit of power of the machinery. So far as high tip-speeds having any influence in producing cavitation, the evidence so far produced is negative. The writer has reliable information of a propeller driving a vessel at a speed in excess of 29 knots, with a tip-speed of propeller exceeding 17,000 feet per minute, and the propeller working smoothly and efficiently.

With the appearance on the marine stage of the fast, high-powered destroyer, fitted with reciprocating engines running at a low rate of revolution, as compared with the practice of to-day, knowledge of the influence of projected area ratio on propulsive efficiency was extended, and when the marine turbine with its high revolutions came upon the scene this knowledge was still further extended until the limits of present-day practice were reached.

Upon the first appearance of the marine steam turbine, attempts were made to utilize its power by fitting two or more propellers of small projected area ratio on each shaft, but after a short period this was abandoned and propellers of high ratio, one to each shaft, appeared and have held the field successfully ever since.

Propeller Refinements Introduced by the Navy Department

Turning now to the other features of the propeller, in 1906 the Navy Department, largely through the influence of Capt. W. Strother, United States Navy, required that the working face of all propellers for important vessels be machined, the backs fashioned to template, edges of blades sharpened and the entire blade surface and the hubs buffed and polished. The result of these refinements was to produce propellers of much more accurate pitch and of considerably less frictional and edge resistance to motion through the water. Also great care was taken with the hubs and hub cones in order to prevent, as far as possible, the formation of eddies at the forward end of the hub and of a vacuum at the after end, thus further reducing losses in the propeller itself.

At the same time a standard form of projected area of the blade was adopted which resulted in producing a standard radial distribution of this area. Also, a standard form of blade section was adopted at this time.

By these means the variables of the propeller entering into its efficiency were reduced to as low a value as possible in order that the propulsive efficiency delivered by the propellers should be little affected by these controllable

variables and the data obtained from the trials of vessels fitted with these propellers, when run over the measured mile, be as little influenced as possible by any factors than pitch, diameter and projected area of the propellers, and by the form of hull and the position of the propeller relative to the hull.

During the past twenty years a large number of patent specifications covering the screw propeller field have passed through the hands of the writer, and almost without exception the ideas covered by them would be found already described in some one or other of the numerous patents on propellers described in Bourne's "Treatise on the Screw Propeller." This work was published in 1867, and a search through its pages will thoroughly repay the inventor who may be dreaming of a revolution in the methods of screw propeller action and of improvements in its characteristic features. Lack of knowledge has undoubtedly misled scores of inventors.

Motorship Development During the War

Risk of Destruction by Submarines Greatly Reduced on Motorships — Motorship Building in Europe and Great Britain

BY J. RENDELL WILSON

WITH one-half of the world seething in war, and the greatest engineers and shipbuilders mainly engaged in productions pertaining to warfare, it is conceivable that there has been little opportunity for development during the past three years of a comparatively new invention, so far as its application to mercantile purposes is concerned. I refer to the marine crude-oil engine—particularly of the true Diesel type, the greatest value of which *at present* is its use for propelling submarines. Had shipowners, especially American shipping men, made a closer and more personal study of the motorship question they long ago would have realized the remarkable value of this class of freight-carrying vessel in eluding blockading submarines.

A submarine, whether running on the surface or submerged all but the periscope, is limited to a range of vision to a very few miles, except in very calm weather, because of being so close to the water. Consequently, its crew has to trail ships by means of their smoke, which, rising several hundred feet in the air, can be seen by the submarine long before they can detect the hull. In the case of a motorship, the latter can pass quietly by the submarine half a dozen miles away without being seen, as she shows no telltale smoke. In a way, it seems incredible that shipowners have not grasped the enormous value of this feature. Surely it ranks higher in importance than the doubt of reliability of the Diesel oil engine that some owners still seem to have. Paying for repairs is far cheaper than having the ships sunk by submarines, and in this connection it may be said that there are motorships that do not have repair bills, and with which the wear and tear is less than with steam machinery.

I do not say that a motorship can get by a submarine every time, but the risk is tremendously reduced, because in average Atlantic weather the submarines' radius of vision of steamers (particularly oil-fired) is about 18 miles, compared with about 6 miles for a motorship, so that with the submarine resting on the surface and lying in wait, the chances are twelve to one in the motorship's favor, taking the steamship chances as even.

The extraordinary demand for ships perhaps has been the most serious hindrance to the development of the motorships. Owing to the high freights and the scarcity of hulls shipowners necessarily have demanded the form of ship that can quickest be built, and, as the facilities for turning out seamers are far better than the facilities for

Fig. 1.—Werkspoor Diesel-Engined Motorship *Juno*

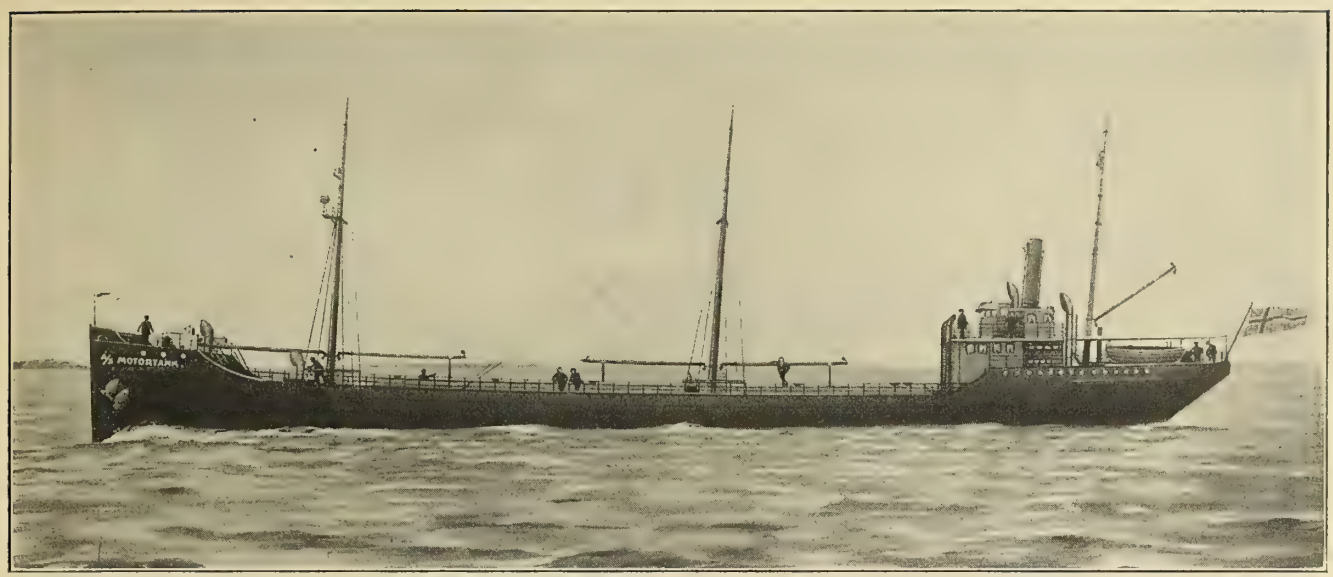


Fig. 2.—Motor Tank Ship, Equipped with Diesel Engine

building motor ships, it is only natural that orders for steamers should be placed, except in the case of small vessels, where it has been found to be quicker to build a wooden motor auxiliary than a small steel steamer. Again, freight rates are so high and shipowning profits so huge that economical operation now becomes a minor consideration. Just at the moment shipowners only have their eye on the present, and seem to be paying little regard to the future. A shipowner will argue, "What matter if I can save $50,000 (£10,250) per annum with a motorship if I have to wait two months longer for the ship, during which period a steamer will earn me $100,000 (£20,500)?" If only shipowners were in the position to construct motorships as fast as steamers, the entire situation would have been changed. The tide will turn, however, and when freight rates drop there is bound to be a rush to build motorships, or to convert steamers to Diesel power, because economy of operation then will be of the greatest importance to shipowners.

Another retarding factor to the motorship development has been the cutting off of Germany from the seas. Just prior to the war the big German shipping men had planned out some extensive motorshipping schemes along this line, and altogether six of the most important Teutonic shipbuilders actually had completed large ocean-going mercantile motorships and their Diesel engines. They are: Blohm & Voss, the Rehierstieg Company, the Weser Company, the J. C. Tecklenberg Company, Fried. Krupps and the Frerichs Company, while a host of smaller concerns were engaged in more modest attempts. I have reason to believe that no small progress has been made in Germany during the war, and it practically is certain that German shipowners have plans for extensive motorship construction after the war, when they will be forced to use the most economic means of transportation of freight. In fact, one of the directors of the Cosmos Line, of Hamburg, who has been in America since the outbreak of war, has taken the opportunity of the period of idleness to make a most exhaustive study of the entire motorship situation, and there are not many such vessels whose

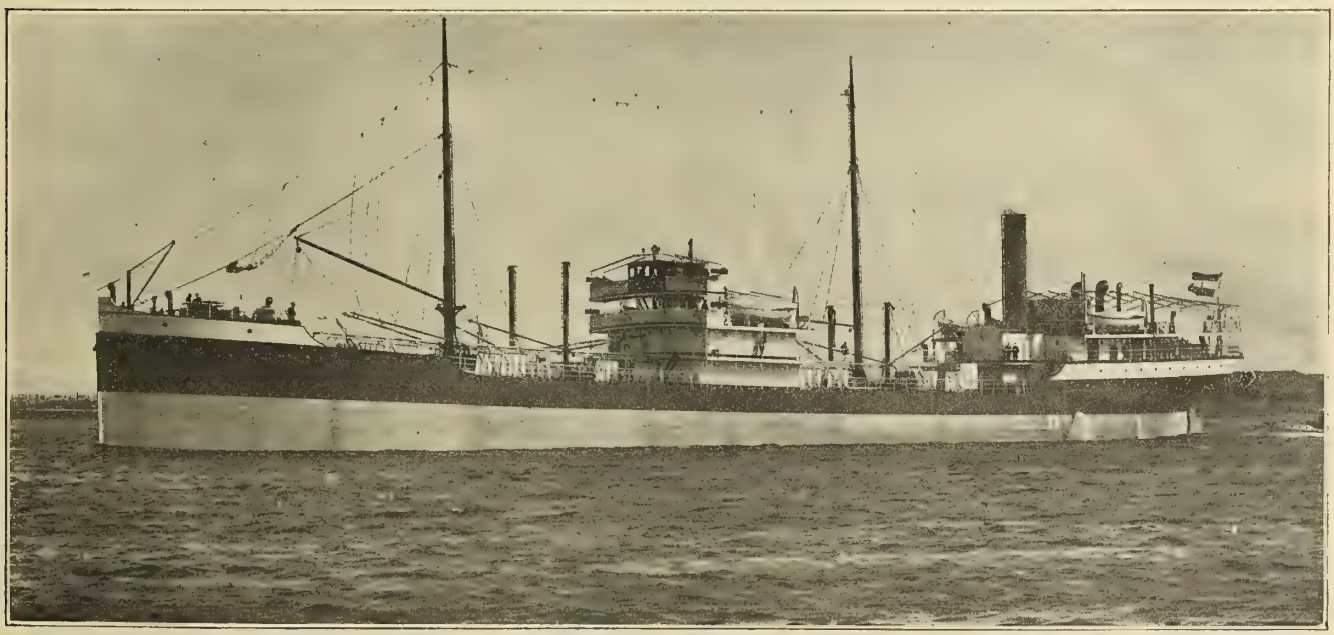


Fig. 3.—Motorship *Artemis*

operations he has not followed; consequently he is a firm believer in the motorship and his company has plans for the establishment of a large motorship fleet of cargo carriers when peace again reigns.

No country has been more difficult to obtain news from than Russia, and the only information that I have been able to obtain since the outbreak of war is that the Caucasus & Mercury Company of Petrograd has decided entirely to abandon steam and revert entirely to Diesel-engined motorships. The war has interfered with their building program to a considerable extent, consequently they only have twenty Diesel-driven craft in service, a dozen of which are large twin-screw passenger vessels of 1,200-brake horsepower (about 1,500-indicated horsepower).

The same policy of entirely abandoning steam machinery has been adopted by the East Asiatic Company of Copenhagen who, by reason of experience, are so sure of the success of the marine Diesel engine, that they placed orders for motorships for delivery in five years' time; also, they converted three steamers to motor power. They even went further than this and sold eleven other large steamships and ordered motorships in their place.

Entire Output of Danish Motorship Builder Sold Up to 1922

I do not think that there is a steamship owner in America who has sufficient confidence in steam-driven freighters that he dare order (at to-day's high prices) a 10,000-ton oil, or coal-burning cargo steamship for delivery in five or six years' time, yet Burmeister & Wain, the Danish motorship builders, have their entire capacity (one ship per month) definitely ordered up to 1922, and not a single steamer will be among them—all will be Diesel-driven motor vessels. One day American shipowners will wake up, and perhaps then it will be too late.

Shipbuilding of all kinds has suffered most severely in Holland, due to that country being unable to obtain any materials whatever from Germany, France or Great Britain. The Netherlands Shipbuilding Company and the Werkspoor Works have orders in hand for a number of Diesel-driven motorships, of which some are for Norwegian owners. Had the material market been better for Holland its shipbuilders would have undertaken orders for a much larger number of Diesel vessels, delays in receiving materials from America making the process of launching and completing ships much slower than in normal times, consequently the motorship production severely has suffered, which indeed is unfortunate, because Holland has turned out some of the world's most successful motorships.

Motorships Building in Norway

Norway has shown the strongest inclinations of all countries to adopt motorships, and in this country alone Norwegian shipowners have a large number of wooden auxiliaries on order, and, as just mentioned, have a number of full-powered, steel-built motor freighters building in Holland. At the end of last year Norway, according to the "Norske Veritas," had 2,036 ships measuring in excess of two and a half million tons, of which 2,143,802 tons consisted of steamers and motorships. How many of these are motorships is not given, but in 1915 her motorship fleet was increased by seven vessels totaling 21,000 tons, so, for 1916, it is fairly safe to assume ten additional motorcraft of 35,000 tons aggregate. On January 1 of this year there were four full-powered steel Diesel motorships of 4,375 tons each under construction, and four full-powered steel Diesel motorships of 4,675 tons each under contract, but not begun, with Norwegian yards. There also were two wooden motorships building, and two under contract. Considering that there were only 77 mercantile ships of all kinds under construction at that date the proportion of motorships is not at all disheartening, if one considers the present conditions.

Practically all the British shipyards have licenses to build marine Diesel engines, or else have produced an engine of their own design; but in most cases the war has entirely upset developments, and now that a "rush program" for constructing standardized vessels has been put through the builders in most instances have been obliged temporarily to lay aside Diesel engines because of their facilities to turn out steam machinery in much quicker time. However, Harland & Wolff have made great preparations for turning out standardized Diesel ships, and already have laid down four freighters of 13,000 tons each, so that the motorship industry is not quite dormant. After the war we can look to seeing large numbers of motorships being built in the British Isles.

Lastly, we will turn to the motor shipping development in our own country, where just at the moment mysterious inquiries are being put out for 200 wooden motorships of about 2,000 tons deadweight capacity in one batch, and another inquiry consists of a number nearly as large, but of vessels of about 4,000 tons deadweight capacity. Who, or what, is at the back of this is hard to say, and may be revealed by the time this appears in print.

American Shipbuilders Prepared to Build Diesel Motors

Full-powered motorships of large size have met with little attention in this country, although since the war three great shipbuilders—namely, the Newport News Shipbuilding & Dry Dock Company, the Wm. Cramp Ship & Engine Building Company, and the New York Shipbuilding Corporation—have acquired European Diesel constructional licenses. Pressure of other work and lack of support from shipowners, however, have prevented them from making the progress that they may have desired. Cramps has laid down a motor freighter of about 12,000 tons and the Brooklyn Navy Yard has completed the 15,000-ton displacement motor tanker *Maumee*, otherwise there is no large motorshipping development to report.

However, the last year has seen a record in the placing of orders for motor-driven auxiliaries of wooden construction, the majority of which are of from 2,000 to 3,000 tons deadweight capacity; also, there are a number of full-powered wooden ships of about this size now building, all of which will be motor driven. The entry of the McIntosh & Seymour Corporation, of Auburn, N. Y., into the marine Diesel engine field is to be recorded, and their first order was for eight 500-brake horsepower engines, for four ships for the Clinchfield Navigation Company, of New York City. Since the war several other companies have entered the marine Diesel engine field, including the Winton Company, of Cleveland; the Atlas Company, of Oakland, Cal., and the Southwark Foundry and Machine Company, of Philadelphia.

Reliability of Marine Diesel Engines.—"Modern marine Diesel engines have reached a stage of reliability so that there is not the slightest doubt that in a few years' time they will be in advance of the steam engine. At present there are motorships crossing the Atlantic running as regularly as steamships, keeping as good, if not better, time than steamers and coming through the heavy weather without any hitch to the motors. I would rather be with a Diesel engine in heavy weather than with a steam job."—J. E. Cole, chief engineer M. S. *Abelia*, in *Motorship*.

Standard Specification for Triple Expansion Marine Engines for Cargo Boats*

Compiled by the Council and Members of the North-East Coast Institution of Engineers and Shipbuilders, 1917

IN the present crisis of the country's history it is the duty of all of us to bethink ourselves and consider how we are to hold our own in the approaching contest for supremacy in the industrial world. As shipbuilders and engineers it is specially incumbent on us to look forward to what is likely to happen after the war, and to prepare for the new conditions as far as we possibly can. Intensified and organized competition from abroad is the least that may be expected. As to whether this will be met or not depends on whether our manufacturers so bestir themselves as to procure not only vastly increased economy in production, but also increased efficiency of their products. Labor questions do not come within our present scope, and we therefore confine ourselves to the scientific and technical factors of the problem, the influence of which cannot well be overrated. Old designs and easy going or antiquated methods will be rigidly overhauled, and, where necessary, must be brought up to date under the guidance of the latest research and reliable experience.

Animated by those views the council of the Institution, after grave consideration, have taken the first step in what they trust may develop into a beneficial and helpful enterprise, and hereunder present for discussion by the members the draft of the guidance specification for reciprocating triple expansion engines intended for moderate-speed cargo boats engaged in general trade. The specification is based on the best practice of the day and the district, and the object in view is the ultimate standardization of parts. There is no intention whatever to change accepted and successful practice, but merely to reduce that practice to a common basis, and to add to it when desirable or necessary, in order to raise performance to the highest pitch of efficiency.

It is hoped that ultimately the specification will be extended to include not only the main engine proportions and scantlings, but also the boilers, auxiliaries and other details. Quadruple expansion engines and geared turbines, as well as internal combustion engines, will also be dealt with as time permits.

The council suggest that the present installment, as and when approved by the members in general meeting, shall be known as "The North-East Coast Institution Specification (1917) for Cargo Boat Triple Expansion Engines." It is hoped that it will be accepted by marine engine builders, and that it may prove beneficial not only in securing the maximum rate of progress in technical advance, but also in promoting convenience and despatch in the purely business sphere. The council propose that discussion in the meantime be restricted to the subject matter of the present draft, and that an annual revision be made in order that the specification may be kept thoroughly up to date, and may command the confidence and promote the ultimate interests of all concerned.

Specification

1. *Indicated Horsepower.*—For calculation purposes in this specification and in average sea conditions the I. H. P. is to be found as follows:

$$I.H.P. = \frac{D^2 S N}{700}$$

D = diameter of low-pressure cylinder in inches,
S = stroke in feet,
N = revolutions per minute. Found as per section 2.

The divisor is adjusted for a referred mean pressure of 30 pounds per square inch.

2. *Revolutions.*—

$$N = \frac{32\,(S+4)}{S}.$$

3. *Boiler Pressure.*—180 pounds per square inch (gage).

4. *Ratios of Cylinder Areas.*—Ratio for 180 pounds pressure.

H. P.	M. P.	L. P.
1	About 2.74	About 7.5
	1	" 2.74

5. *Cuts Off at Sea Power.*—

About 57.5 percent. 57.5 percent. 55 percent.

6. *Speeds of Steam.*—The mean steam speeds to be calculated as follows:

$$\frac{\text{Area of cylinder in square inches} \times \text{piston speed in feet per second}}{\text{Area of pipe, port or opening in square inches}} = \text{speed in feet per second.}$$

Table of mean steam speeds in feet per second:

	H. P.	M. P.	L. P.
Main steam pipe	110	—	—
Port opening	110	150	240
Steam ports	80	85	100
Exhaust passage or pipe	60	65	75

Width of Steam Ports.—Width of ports to be about 0.8 of diameter of cylinder.

7. *Maximum Load.*—The maximum load on main working parts to be taken as the product of the area of H. P. cylinder in inches and the boiler pressure in pounds per square inch (gage).

8. *Crankshaft.*—The diameter of crankshaft in body is to be nearest ⅛ inch above Lloyd's rule, and the proportions of the remaining parts to be not less than the following:

(1) Diameter of crankpin to be equal to diameter of shaft.

(2) Diameter of crankshaft in web to be equal to diameter of shaft plus ½ inch.

(3) Diameter of webs to be equal to diameter of crankpin by 1.85.

(4) Thickness of webs to be equal to diameter of shaft by 0.62.

(5) Thickness of couplings to be equal to diameter of shaft by 0.25.

(6) Six coupling bolts to be used for shafts up to and including 15 inches diameter. Nine coupling bolts to be used for shafts above 15 inches diameter.

*(7) Diameter of pitch circle of coupling bolts to be 1.43 diameter of crankshaft.

*(8) Diameter of coupling bolts to be equal to:

* Paper read before the North-East Coast Institution of Engineers and Shipbuilders, on February 3, 1917.

* These two rules may be varied, provided that equivalent strength is given.

$$0.7 \times \sqrt{\frac{\text{diameter of shaft}^3 \text{ in inches}}{\text{number of bolts} \times \text{diameter of pitch circle in inches.}}}$$

Bolts to be parallel.

9. *Length of Connecting Rod.*—Length of connecting rod between centers to be twice the stroke or four times the crank radius.

Diameter of Connecting Rod.—Connecting rods may be made parallel, same diameter as piston rod body.

Connecting Rod Top Ends.—Connecting rods to have single top-end gudgeons for all engines having H. P. cylinders of 25 inches diameter and under.

10. *Crosshead Guides.*—Main crosshead guides to be of the single type in all sizes of engine.

Load on Main Crosshead Guides.—Maximum load in pounds on crosshead guides to be taken as:

$$\frac{\text{Area of H. P. cylinder in square inches} \times \text{boiler pressure in pounds per square inch (gage)}}{4}$$

11. *Maximum Pressures on Principal Bearing Surfaces.*—

	Pounds Per Square Inch
Main bearings	250
Crankpins	500
Crosshead gudgeons	1,000
Guide shoes (ahead)	55
" " (astern)	110

Diameter by length to be taken as area of bearings.

Overall length by overall breadth as area of guide shoes.

12. *Maximum Stresses on Principal Working Parts.*—

	Pounds Per Square Inch
Ingot steel piston rod at screw	6,000
Piston rod body (after deducting ¼ inch from diameter to allow for returning)	3,000
Piston and connecting rod bolts at screw	5,500
Main bearing bolts	4,500
Main bearing keeps (if forged)	6,000
Connecting rod bottom end keep (if forged)	7,500
Piston rod keep (if forged)	7,500

(The keeps are calculated as beams with distributed load and supported ends.)

13. *Valve Gear.*—The valve gear sizes to be determined from the load on the I. P. slide valve spindle, calculated as follows:

Load in pounds $= 0.165\ [54\ (A\text{-}B) - 9\ C]$,

Where A = area of face of I. P. valve in square inches,

B = combined area of steam ports in valve face in square inches,

C = combined area of exhaust ports in valve face in square inches.

Valve Spindles.—Diameter of valve spindles at gland to be not less than

$$\frac{\text{Diameter of piston rod at gland}}{2} \times \tfrac{5}{8} \text{ inch.}$$

Maximum Pressures on Bearing Surfaces of Valve Gears.—

	Pounds Per Square Inch
Link block gudgeon	500
" " slippers	300
Eccentric rod top end pins	500
Eccentric sheaves (ahead and astern)	85

14. *Thrust Block.*—When of horseshoe type the pressure on thrust collars not to exceed 70 pounds per square inch when calculated from indicated thrust, which is determined as follows:

$$\text{Pounds indicated thrust} = \frac{I.\ H.\ P. \quad 33{,}000}{\text{Pitch in feet} \times \text{revolutions per minute}}$$

15. *Circulating Water.*—The amount of circulating water supplied to be forty times the feed, taking the latter at 15 pounds of steam per indicated horsepower per hour.

16. *Main Engine-Driven Reciprocating Circulating Pump (Double-acting).*—To be proportioned to deliver the above quantity of water at a displacement efficiency of 80 percent.

17. *Maximum Speeds of Circulating Water.*—The speeds of circulating water are to be calculated as follows:

$$\frac{0.8 \text{ area of bucket in square inches} \times \text{bucket speed in feet per second}}{\text{area of passage in square inches}} = \text{speed of water.}$$

Approximate Speeds in Feet per Second.—

	Feet Per Second
Main injection	9.0
Passages in pump	5.0
Valve grids	6.0
Past lift of valves	9.5
Discharge pipe	7.5

18. *Air Pump.*—Capacity of air pump not less than one-sixteenth of the capacity of L. P. cylinder.

19. *Main Engine-Driven Feed Pumps.*—Capacity of *each* engine-driven feed pump 1/700th of capacity of L. P. cylinder.

20. *Pump Gear.*—Load on pump gear to be calculated as follows: Load in pounds = 25 (area of air pump bucket + area of circulating pump bucket) + 15 (area of both feed pump rams + area of both bilge pump rams). All in square inches.

Maximum Pressures on Pump Gear Bearing Surfaces.—

	Pounds Per Square Inch.
Pump link pins	400
Engine link pins	300
Pump lever center gudgeon bearings	250

For cargo vessels of large tonnage it is recommended that the circulating and feed pumps be independently driven pumps.

21. *Utilization of Heat in Exhaust Steam from Auxiliary Engines.*—A source of very considerable economy in a marine installation being the complete absorption by the feed water of the heat in the exhaust steam from the various auxiliaries, including the steering engine, electric-light engine and evaporator, such a vacuum should be carried in the main condenser as will enable this to be effected in all seas in which the vessel trades. A vacuum of 27 inches maintained in the steam space of the condenser, the temperature of the sea being 70 degrees F. (barometer 30 inches) has been found to meet these requirements on an average cargo boat.

22. *Cooling Surface.*—In determining the amount of cooling surface per indicated horsepower average at sea, provision should be made for the rapid initial degrading effect of oil and scale on the tube surfaces, and also for the permanent prejudicial effect on the condensing efficiency of the residual air in the condenser.

23. *Air Extraction by Steam Jet.*—When a steam jet is employed for the extraction of air, and a suitable design of condenser is adopted, the greatly increased efficiency of the condensing surface enables a higher temperature of feed to be obtained, and for a given vacuum the sizes of air pump and circulating pump to be considerably reduced, thereby saving pumping power and total weight.

24. *Pressure Losses in Vacuum System.*—It is important to minimize the loss in absolute pressure between the steam space in the condenser and the mean vacuum line as shown on the L. P. indicator diagram, and also the loss between the steam space in the condenser and the air-pump suction pipe.

In good practice (*a*) the vacuum line should scale 12¼

pounds per square inch below the atmospheric line when the vacuum in the steam space of the condenser is 27 inches; (*b*) the speed of steam over the condensing surface should be such that the total resistance through the condenser does not exceed one-tenth of an inch of mercury or 1.36 inches of water, as measured by a resistance gage.

25. *Prevention of Delivery of Oil to Boilers.*—It is desirable that the oil should be separated from the auxiliary exhaust steam before it is used to heat the feed water, but in any case the feed water must be passed through a satisfactory filter before delivery to boilers.

26. *De-aeration of Feed Water.*—Means should be provided for the de-aeration of feed water before it enters the boiler, with the object of preventing corrosion.

27. *Prevention of Heat Loss by Lagging.*—Heat loss by radiation from unprotected surfaces being a very appreciable factor in the ultimate economy of a steam installation, the lagging of boilers, steam pipes, cylinders, auxiliary exhaust pipes and feed pipes should receive expert attention in order to promote efficiency by means of an adequate thickness of non-conducting material applied in a workmanlike manner.

Recent Progress in Dredging Machinery*

Brief Descriptions and Performance Records of Latest Types of Bucket, Suction and Dipper Dredges

BY WILLIAM BROWN

THE paper deals with bucket dredgers, suction dredgers of the "cutter," "drag," and "moored" types, and dipper dredgers.

Each of these types, within its limits, is recognized as being best suited for particular classes and conditions of dredging, and the vessels described in the paper have not been selected because of any phenomenal dredging done by them, but because special attention has been devoted to their design to meet the several conditions of their intended use.

With regard to the question of dredging costs, no fair comparisons can be made unless due regard is had to all the items—labor, coal, oil and stores—and to the physical conditions met with. Comparisons are only of value when the conditions are fully explained, when all corresponding details are included in the charges, and when the methods of accounting at the various ports are reduced to common terms.

Bucket Dredgers

The bucket hopper dredger *Silurus* is taken to represent the most modern dredger of the bucket type, and particulars are given of the work done by the dredgers *Corozal, Kuphus* and *Octopus.*

The *Silurus* is a twin screw bucket hopper dredger built of steel to Lloyd's requirements, for the port of Bombay.

	Feet
Length between perpendiculars	260
Breadth, molded	46
Depth, molded	20

The hopper has a capacity of 1,500 tons. The steam generating plant consists of two marine cylindrical multitubular boilers, and there are two main engines of compound surface condensing type for propelling the vessel, or for driving the dredging gear as required. The gearing between the main engines and the upper tumbler is so arranged that with a constant piston speed of the main engines two different speeds of buckets can be obtained. Two sizes of buckets are provided, one set of 42 cubic feet capacity for excavation in soft material, and a smaller set each of 22 cubic feet capacity.

Clay-Cutting Suction Reclamation Dredgers

These dredgers give satisfactory results in all classes of clay, as well as in free material, and on occasion cutter dredgers have been employed on stiff blue clay and on hard chalk, which have been found a severe test of the capabilities of powerful bucket dredgers. The cost of repairs and renewals in cutter dredgers when working in hard material is less than with bucket dredgers, owing to their wearing parts being much fewer, the only parts of importance subject to hard wear being the cutter blades and liner plates of the pump, as against the buckets, pins and bushes, tumblers, and ladder rollers of a bucket dredger.

The clay-cutting suction dredgers *Jinga* and *Kalu,* which are described, were ordered by the Bombay Port Trust for carrying out a very large reclamation scheme undertaken by them.

These vessels were designed to be capable of dredging 2,000 cubic yards of soft clay and mud per hour from a depth of 30 feet, and discharging the material so dredged to a distance of 4,500 lineal feet on shore. The dredging depth was subsequently increased to 40 feet. Their dimensions are:

	Feet
Length on main deck	205
Breadth, molded	42
Depth	13

The dredging pump is driven by a set of triple expansion inverted direct acting, surface condensing engines. The boilers are four in number, of the cylindrical multitubular type and provided with Howden forced draft. The cutter is of rotary pattern.

In the Twante Canal, connecting Twantewa with Rangoon, suction cutter dredgers were employed to cut the clay that formed the bank and bed of the canal and pump it through a floating pipe line to alongside of wherever it was desirable to deposit it upon the bank, and then raise and discharge it by means of a floating terminal pontoon with a raised pipe overhanging the bank.

Three suction cutter dredgers, each with 1,000 feet of floating pipe line and a terminal pontoon with 80 feet overhang, were ordered by the Indian Government. The *Oswald* and *Campbell,* the two smaller boats, both have 24-inch diameter suction and discharge pipes, and the *Lees* has a suction pipe 30 inches in diameter and a discharge pipe 27 inches in diameter.

Moored Suction Dredgers

At Durban, where suction dredgers of the moored type have been employed with excellent results, the depth of

* Abstract of a paper read before the Institution of Civil Engineers, on January 9, 1917.

water at the entrance in 1884 was 7 feet 2 inches, which had become 36 feet 5 inches in 1914, mainly as a result of dredging. Up to the end of the year 1914 the total volume of solids removed at Durban amounted to 81,737,292 tons.

The chief difficulty of dredging on the bar at Durban is that the work has to be carried out in the open sea and subject to heavy weather. To meet such conditions, the suction pipes of the Durban dredgers are in two parts, joined together by flexible armored piping spanned by universal joints. The upper end of the suction pipe is carried on a trunnion bearing near the deck, and the nozzle end is controlled by hydraulic hoist gear designed to maintain the two lengths of pipe relative to each other in the same line of axis when working at any depth. The hoisting gear is so arranged that when the length of pipe below the joint deviates from its axis with the upper length, the hoisting gear automatically raises the lower length, thus allowing the lower end to clear the obstruction which caused the deviation.

At Lagos, a pump dredging plant is used in connection with deepening the bar at the entrance to the harbor, which has hitherto been subject to considerable fluctuations. The dredgers employed particularly for this part of the work at Lagos are the pump hopper dredgers *Egerton* and *Sandgrouse*. In their main features they are much alike, the *Sandgrouse* having a hopper capacity of 1,800 tons, while the *Egerton's* hopper capacity is 1,200 tons.

The dimensions of the *Sandgrouse* are:

	Feet	Inches
Length	291	0
Breadth	45	0
Depth	19	9

and she is fitted with two sets of triple expansion, surface condensing engines driving twin screws, and one set of triple expansion engines directly connected to the dredging pump. Steam is supplied by three marine cylindrical multitubular boilers. The suction pipe arrangement permits of entire flexibility in any direction.

The remaining dredging plant at Lagos has been principally provided with a view to the reclamation of certain swamps. The reclamation dredger is specially arranged for pumping from barges alongside by means of two independent dredging pumps so arranged that they may work either singly or in series, depending upon the distance the material is to be discharged.

The suction cutter hopper dredger for Lagos, now under construction, is fitted with one set of triple expansion surface condensing engines arranged to drive the dredging pump or the propeller, as may be required.

The outboard suction pipe is fitted with a special drag nozzle for use when dealing with compact sand, while a spiral rotary cutter is provided for dealing with clay and harder material.

A special feature in this vessel is that four independent automatic mooring machines, four capstans, and one steam windlass are provided for mooring purposes.

Drag Suction Dredgers

The *M.O.P. 210.C* and *M.O.P. 211.C* are selected to illustrate the drag suction or moorless type of dredger. They were specially designed and constructed to meet the conditions prevailing at Buenos Aires, and the character of the material there met with.

These vessels have a hopper capacity of 1,650 cubic meters and are each fitted with four sets of triple expansion engines. The engines are arranged in pairs, so that all four sets are available for driving the dredging pump or the propellers separately, or two sets may drive the dredging pumps and two sets drive the propellers at the same time, as may be required. Steam is supplied by four cylindrical multitubular boilers.

When commencing work the vessel is steamed slowly ahead on the desired line of excavation, and the drag nozzle is lowered into the material until the inlet opening of the nozzle is completely sealed by the clay to be raised, so that the load on the hopper is made with the minimum amount of added water.

The drag suction dredgers *Cormorant* at Rangoon and *Canterbury* at Lyttelton are of the same type as those employed at Buenos Aires. The *Cormorant* is 204 feet long, 38 feet molded breadth, and 17 feet 6 inches deep; hopper capacity, 27,000 cubic feet, mean draft, 14 feet 3 inches, and speed per hour on measured mile, 9½ knots. She is fitted with patent steering jets, so that the vessel can be steered entirely independent of the rudder. The dimensions of the *Cormorant* and the *Canterbury* are alike. The only difference of vital importance is the arrangement of the propelling and pumping machinery. In the *Cormorant* one pump was fitted driven by independent engines, while two sets of engines were fitted for propelling, each driving one twin screw direct. In the *Canterbury* the machinery arrangements are similar in all respects to the arrangements already described for dredgers *M.O.P. 210.C* and *M.O.P. 211.C*.

Dipper Dredgers

To illustrate this type of dredger, the modern 15 cubic yard dipper dredgers *Gamboa* and *Paraiso*, employed on the Panama Canal, have been selected.

The ability of these dredgers to dig into a bank of shale, sandstone, lignite, or any of the softer rocks, to dispose expeditiously of a rock too large to pass through the dipper, to dig to 50 feet depth, and load into scows of almost any size, makes them very valuable tools for work of this class. They are capable of dredging 7,000 to 10,000 cubic yards of rock per day of twenty-four hours, depending on the degree of hardness of the material. The material handled by them is loaded into bottom-door steel dump scows.

The principal features of the *Gamboa* and *Paraiso* are the following:

Each dredger has two dippers respectively of 15 and 10 cubic yards capacity. The dipper handle is 72 feet long. The main hoisting engines are of the twin tandem compound type. The winding drum is graduated so as to give a low speed when digging. The swinging engine is of the double cylinder high pressure type, with steam-operated link reversing gear. The dredger is fitted with three spuds. The forward spuds are placed far enough back to allow a swing of 180 degrees for the boom. The third spud is placed centrally at the stern.

S. S. Minnesota Enters Transatlantic Service.—The American freight steamer *Minnesota*, of 20,718 gross tons, sold recently by the Great Northern Railway Company to the International Mercantile Marine Corporation for a sum reported at $2,750,000 (£564,000), sailed on February 15 from San Francisco for New York and London. The vessel, which has been laid up in San Francisco for over a year, has been reboilered by the Union Iron Works Company and has been fitted for the transatlantic trade. She is the largest vessel thus far to pass through the Panama Canal.

Government Shipbuilding Reports Discontinued.—According to notices just given out by E. T. Chamberlain, Commissioner of Navigation, publication of the weekly shipbuilding statements formerly issued by the Bureau of Navigation is discontinued indefinitely.

Changes and Advances in Marine Auxiliaries

Increased Speed, Better Materials, Improved Workmanship and Adoption of Rotary Power Units Distinctive Features

BY W. D. FORBES

IT is an interesting, yet not difficult, task to consider the changes and advances made in marine auxiliaries since the first issue of MARINE ENGINEERING was laid before the engineering world, as the two decades which have passed come well within the memory of many. It would, of course, be impossible to go into the details of such improvements, so this article will confine itself to generalities, but from the experience of the past twenty years it is possible and quite proper to suggest one or two lines of future improvements in ship auxiliaries.

One of the first things to impress one in studying the matter would be the advance in speed of the various auxiliaries. This would be very apparent by comparing the slow-moving, direct-acting pump to the high-speed centrifugal pump—motor or turbine driven. Probably there never was a more unsatisfactory thermo-dynamic engine than the direct-acting pump, and there certainly never was a more widely used and popular mechanical article put upon the market. To offset its disadvantages it has simplicity, compactness and low cost to recommend it. It has been improved in design since its introduction, but it has not been improved in its workmanship.

INCREASE IN SPEED

The increase in the speed of auxiliaries can be clearly traced partly by the enormous advance in the quality of material, and the United States Navy should be given the honor of having brought about, very largely, this condition. When its specifications first demanded the high-grade material now common, steel manufacturers fairly gasped at the requirements, but the Navy was insistent, and to-day the then supposed "impossible" demand has become the possible. About twenty years ago the Navy was in what might be called the 88-10 and 2 period and somewhat hidebound in its ideas. To-day this condition has entirely changed and the standard set by the Navy has worked its way into the commercial world.

Increased speed and better material would in themselves make toward an advance, but, coupled with these, workmanship has marvelously improved. The introduction into general use of hardened material, machined by the emery wheel, has raised the standard of wearing quality by the production of truer surfaces. The selection of composition after many trials, both in the laboratory and empirically, has aided in making all auxiliaries far more certain in their action for long periods of time. Since the days of the chase of the *Itata* the constant breaking down of blower engines, as then noted, is no longer to be expected, whether the blower is run by electric motor, steam turbine or reciprocating engine, and it can be truly said that certainty of functioning of all auxiliaries is most marked in the twenty years that have passed. To-day the marine engine room is not filled with men whose hearts are in their mouths during the voyage for fear of auxiliary breakdowns.

During the period named the introduction of electric light aboard ship has contributed more to the safety and comfort of all hands than any single advance. Electric generators and their motive power units are now thoroughly reliable, and it, of course, follows that the electric motors are equally dependable. Also satisfactory storage batteries are now obtainable, adding greatly to the comfort of those in charge.

The continuous rotary motion in moving machinery is self-evidently a condition which would make for smooth running and lasting qualities in driving ship auxiliaries. The first of these was the electric motor, and when coupled to a fan, and the plant was in proper balance, there was no vibration and but little noise. The stillborn child of years ago, the steam wheel, followed the motor as a continuous drive, and it was brought to life and has become a most robust child, although by no means yet a man; for it must be remembered that, like human growth, it will take the steam turbine time to mature. Further, it can be safely predicted that the steam turbine will not become just a man, but a giant.

The certainty of action and lasting qualities of auxiliaries have been greatly aided by the improvement in the quality of lubricants obtainable. Especially has their value been added to by their application to bearings through the "forced system," as it is called, of lubrication. Without these important conditions the advance in design, material and workmanship would have availed little comparatively.

By means of centrifugal pumps of several stages pumping water into the boilers has been robbed of the danger of oil being introduced into them, and this is no mean gain. We have had a very satisfactory advance also in the increased efficiency of centrifugal pumps.

In all the designs referred to there has been great care taken to make inspection, and even repairs, easier than heretofore. In considering all continuous rotating mechanical appliances, however, the matter of repairs has changed and it might be broadly said that a rotative unit will either work or it will not. When it does not work it generally has to be entirely replaced, while with reciprocating units usually one particular piece has given out which can be replaced with comparative ease.

INTERCHANGEABILITY DESIRABLE

To point out now the things which have not been done in the past two decades, but which should have been done, or at least started, it might be said that more thought should have been given to making ship auxiliary units interchangeable; that is, the engineering world should strive to have makers of various auxiliaries hold to certain standards which would allow, say, a pump outfit made by White interchangeable, when of the same capacity, with one of Brown's make, as far as its holding down bolts, steam supply, exhaust, suction and discharge can be made uniform as to spacings, position and sizes. What this would mean will be readily understood after a moment's thought by shipowners, engineers and men in the engine room. It would mean economy both in time and money, which is the vital point in all business enterprises, whether afloat or ashore.

There is also room for the naval architect to improve conditions by having standard positions for the various auxiliaries, as for instance, having a boiler injector always located in a certain position and its control so

manipulated that one make would not require one movement in order to start it while another make would have to be handled in just the opposite direction. It is, of course, understood that ships vary in their engine room layout and this suggestion of standard position could not be adhered to, to the inch, yet condensers, for instance, could always be put on the port side and electric lighting plants on the starboard side forward. Especially it would seem that this idea should be considered by the Navy, for obvious reasons.

Evidently with the increased speed, better design, material and workmanship there has been a gain in weight and space. Considering the condenser as an auxiliary it seems rather strange that there has been so little advance in its construction. Some years ago there was brought to the writer's notice a plate condenser which on test showed a very decided advance in efficiency over the regular tube, so well known. If my recollection is correct, there was a saving in both weight and space amounting to 80 percent, a most desirable gain. The invention was a Swedish one, but there must have been some reason why it did not come before the public commercially, and it is to be regretted that it was not followed up.

The use of the internal combustion engine as an auxiliary has at least one or two places aboard ship; that is, for wireless communication and, further, for running the lights aboard ship in case of accident which would result in flooding the engine room. Such an engine can be placed on the upper deck, where it will continue to operate until the ship sinks, thus materially aiding in getting boats safely overboard and preventing confusion which would inevitably occur in darkness.

To recapitulate, it can be said that auxiliaries have advanced in twenty years in efficiency, wearing qualities and certainty of action, coupled with a gain in weight and space.

Improvements in Marine Engine Room and Fire Room Auxiliary Machinery

Increased Steam Pressures and Use of Superheated Steam and Oil Fuel Responsible for Changes in Pumping Machinery—Feed Heaters

THE last twenty years has seen a rapid change in all lines of pumping machinery in marine circles. Increased steam pressures, the use of superheated steam, and the increased use of oil for fuel have been the three chief causes for this change, and the nature of the changes is apparent from the following information supplied by the Worthington Pump & Machinery Corporation.

As fire room auxiliaries the functions of the pumps have been added to by the demand for suitable designs for pumping oil from ships' storage tanks to the settling tanks whence the fire pumps take their supply, forcing it through the heaters to the burners. At the burners it is necessary to atomize the oil either by mechanical means, better known as high-pressure service, or by the introduction of steam or air, known as low-pressure service.

Fig. 1 shows a typical installation of two duplex pumps and receiver, all mounted on a common base. The receiver contains the heating coil to which the exhaust steam from the pumps can be passed. A similar arrangement is also made up of two single pumps.

Fig. 2 shows the design of the oil-pumping unit particularly adapted for marine and navy service. It is double in every respect, so that all parts for one complete outfit can be cut out and not interfere with the continuous operation of the plant. The heaters are of the six-pass, multi-current type, which insures the greatest degree of heat with a minimum amount of steam.

For installations where floor space is very limited, double units similar to Fig. 3 are in common use. These pumps can be bolted either to a bulkhead or column and oil pumped through a heater of either horizontal or vertical multi-current type.

Fifteen or twenty years ago boiler pressures began to rise, until to-day pressures of 250 and 300 pounds per square inch are in common use. In addition to this, the practice of superheating the steam has come into common use. Coincidently with these changes, marine engineers have demanded a restriction of the use of lubricants in the steam cylinders and valve chests of auxiliary pumping machinery. Some have carried it even to the stage of totally dispensing with the use of oil, graphite or other lubricating mediums.

These changes necessitated radical re-designing of both steam and water ends of direct-acting pumps and other marine auxiliaries. The flat unbalanced slide valve has

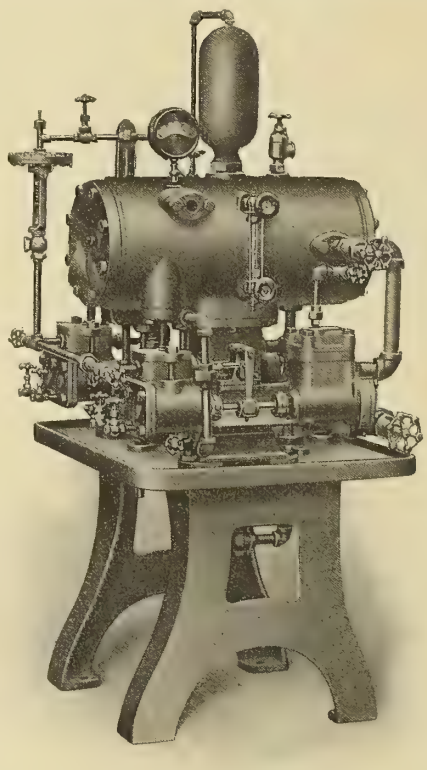


Fig. 1.—Duplex Pumps for Low-Pressure Oil-Burning System

always been preferable to the piston valve, owing to its steam tightness, but the increased pressure acting on the necessarily large slide valves causes an excessive load on the valve gear and its use becomes impracticable. The piston valve, being of the balanced type, partly remedied this trouble, but had the objection of leaking steam after the piston became slightly worn. The advantages of both of these types have been used in different combinations, developing from the original stage, as shown in Fig. 4 to the latest styles, of which Fig. 5 shows a typical case.

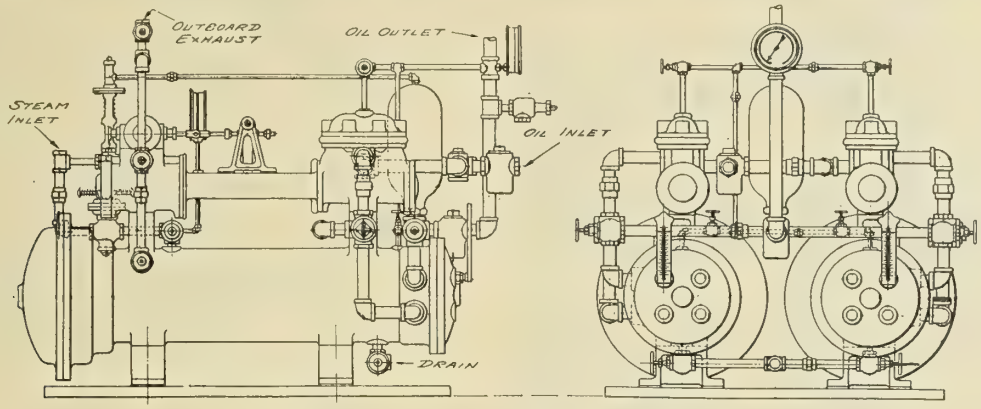


Fig. 2.—Blake-Knowles Fuel Oil Pumping System

this type is the small auxiliary mechanically-operated valve, which, when operating under high steam pressure, results in only a light load on the operating mechanism. The main valve has the added advantage of being of the flat type and always steam-tight, and, in addition, being operated by steam-thrown auxiliary plunger.

The ever-increasing demand in the marine service for better steam economy has led to the further re-designing of direct-acting steam valve gears, and now a very successful cut-off valve has been developed. This cut-off valve, combined with the long-stroke simplex pump for feed service, is now capable of operating with a steam consumption that will compare very favorably with any turbine-driven unit operating on similar service. Each of these types of pumps has its proper place, depending upon the installation, and in some cases, particularly in

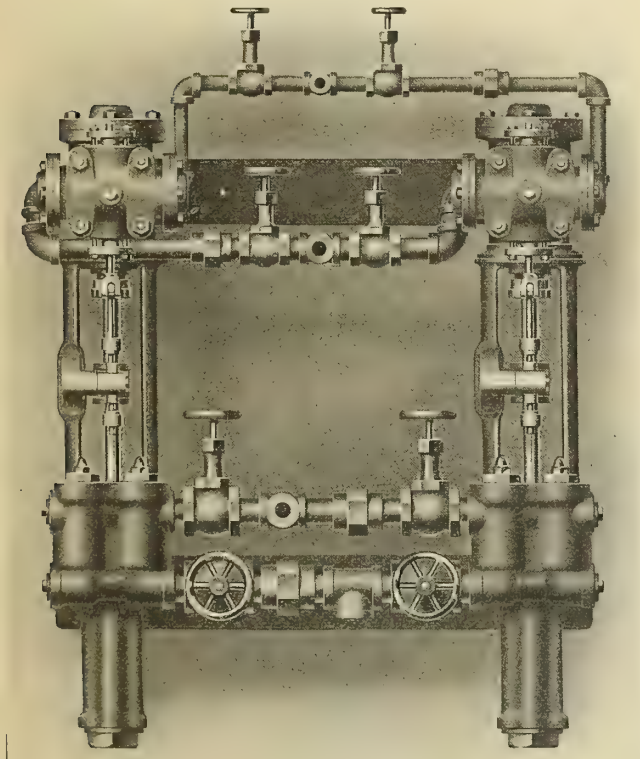


Fig. 3.—Vertical Fuel Oil Pumps (Double Units)

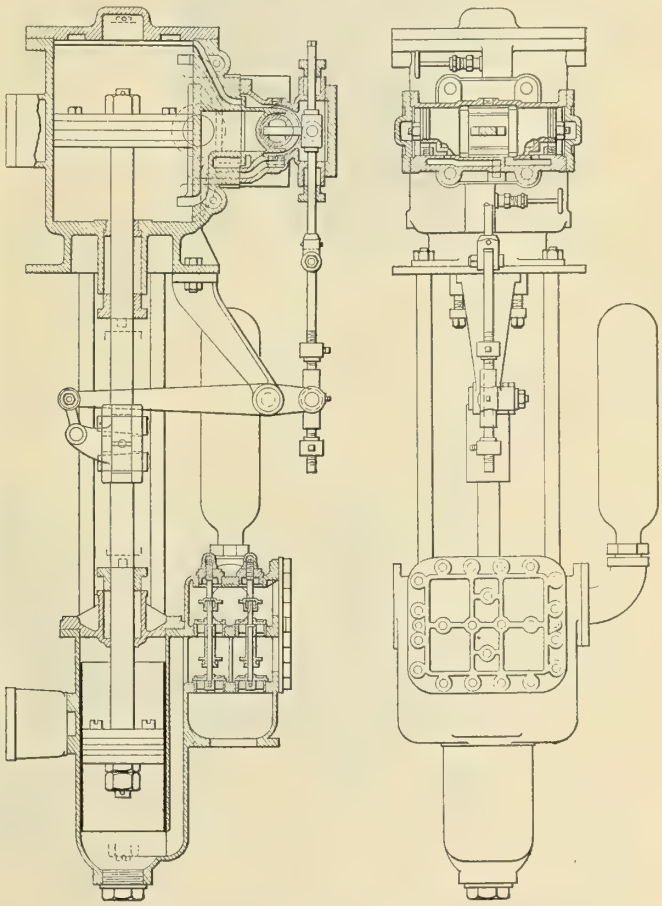


Fig. 4.—Original Design Simplex Vertical Piston Pump

The section through the steam cylinder and chest, as shown in Fig. 6, clearly illustrates how these two principles have been developed into the most up-to-date type of valve gear for single direct-acting pumps. This valve gear can be used equally well on horizontal or vertical machines. The particular advantage of a valve gear of

small sizes up to capacities of 6,000 to 8,000 horsepower, the direct-acting pump is the most economical arrangement for the consumption of fuel, while in the larger sets

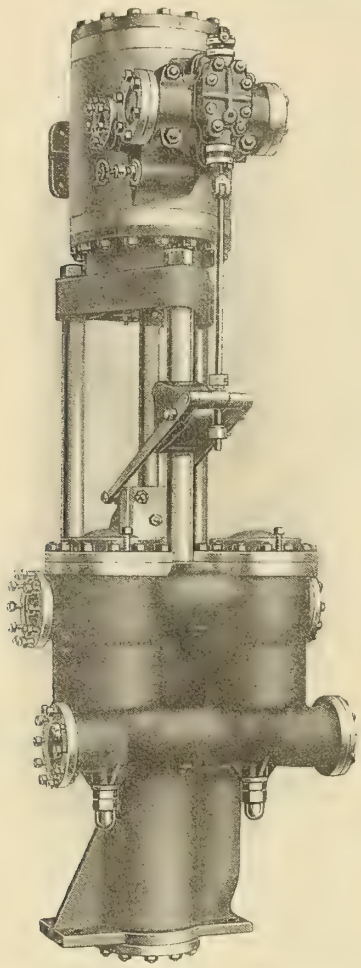


Fig. 5.—Latest Type Vertical Simplex Pump

it will be undoubtedly found, under proper working conditions, that the steam turbine set has the advantage in fuel economy.

The cut-off valve gear for vertical direct-acting pumps is in general similar to the latest styles of simplex gear referred to above, with the addition of two adjustable cut-off valves. These, like the auxiliary, operate on the back of the main valve. Instead of cushioning the reciprocating parts on the exhaust steam at the end of the stroke, as in the ordinary simplex pump, the speed of the moving parts is reduced by the decreasing steam pressure, due to the cut-off. In addition to the improved steam economy through the use of this gear the action of the pump operated on this principle is extremely smooth and quiet. The reversal is quick, but without shock to the pipe line. Should it be desired to operate the pump at any time without the cut-off action the gear may be turned back so that the cut-off valve will close the steam ports and the piston may then be cushioned in the regular manner by the proper adjustment of the cushion valves. With the use of a long-stroke simplex pump and cut-off valve

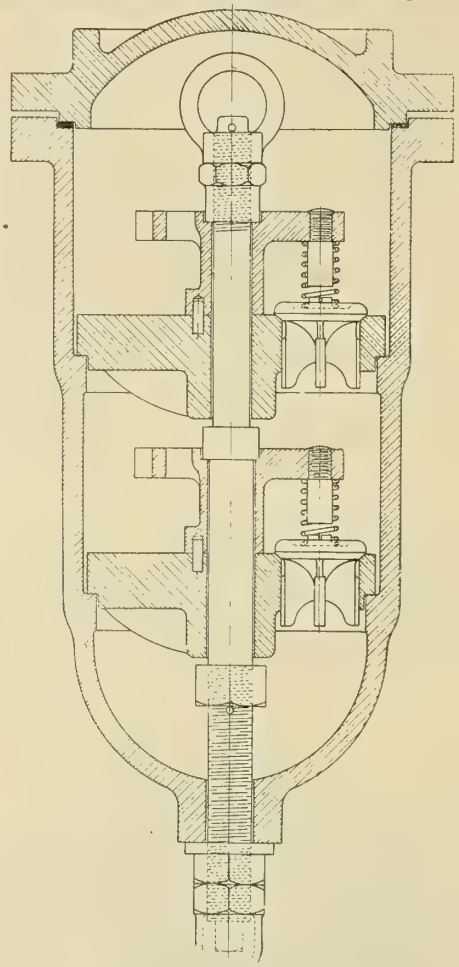
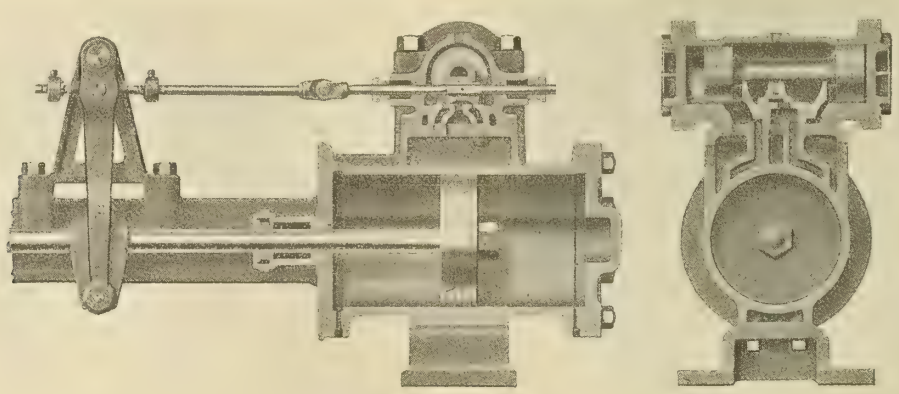


Fig. 8.—Valve Service in Water Cylinders



Figs. 6 and 7.—Sectional Views, Showing Stuctural Features of Steam end of Blake-Knowles Simplex Style "A" Pump

gear, together with a properly-designed air chamber, all shock may be eliminated from the feed line and results similar to those obtained from centrifugal units are readily obtainable.

Water cylinders have been modified considerably. The

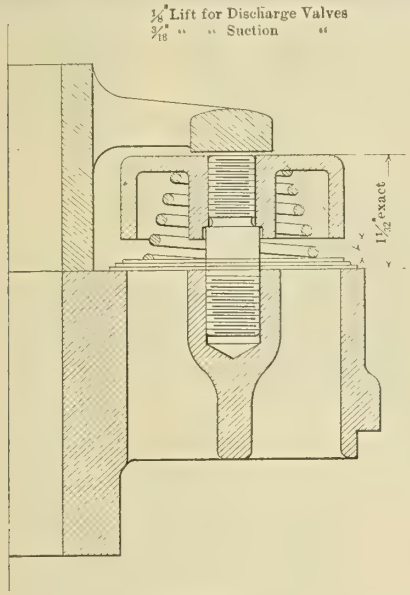


Fig. 9

tendency in most cases has been to eliminate all flat surfaces and substitute cylindrical parts to better meet the demands for the high pressures and keep within reasonable limits of weight. The most common type of pump of this kind is shown in Fig. 5, involving all the features of cylindrical surfaces.

In conjunction with the re-designing of the water cylinders various improved types of water valve service have been brought out. Fig. 8 is a typical arrangement in which the entire internal valve gear can be withdrawn by the removal of a lock nut at the bottom and cover at the top and can be as easily replaced. Bevel-faced, wing-guided valves may be used as in Fig. 8, or valves of the kinghorn or three-disk type with suitable decks substituted, similar to those shown in Fig. 9.

Another type of more recent design and particularly adapted for feed pumps and oil cargo pumps is shown in Fig. 10. This valve is of an annular double-ported type

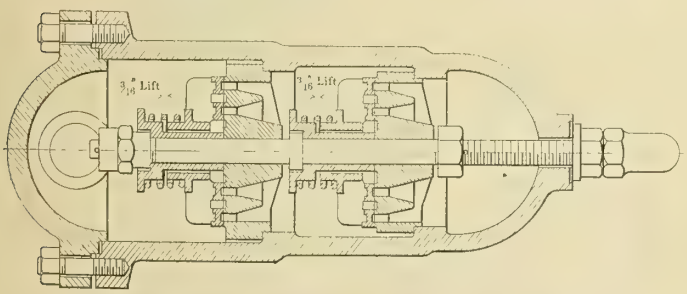


Fig. 10.—Double-ported Annular Pump Valve Service

and has the merit of a very low lift, thereby reducing the valve noise and slip to a minimum and permitting higher speed of operation.

For pumps handling cold water and with not too excessive a pressure, rubber valves may be used, but ordinarily after a comparatively short length of service it is found that the valve will show wear, due to the cutting of the valve disk by the ribs of the seat. This difficulty has been eliminated by the development of the rotating valve shown in Figs. 11 and 12. The distinctive feature of this design is the partial rotation of the valve which occurs every time it lifts from its seat, causing the point of contact between valve and seat ribs to change constantly, thus effectively distributing the wear over the

Fig. 11.—Rotating Pump Valve

Fig. 12.—Details of Rotating Pump Valve

entire valve face, which prevents scoring and accordingly prolongs the life of the valve. This action is secured by the inclining of the ribs of the valve seats so that the

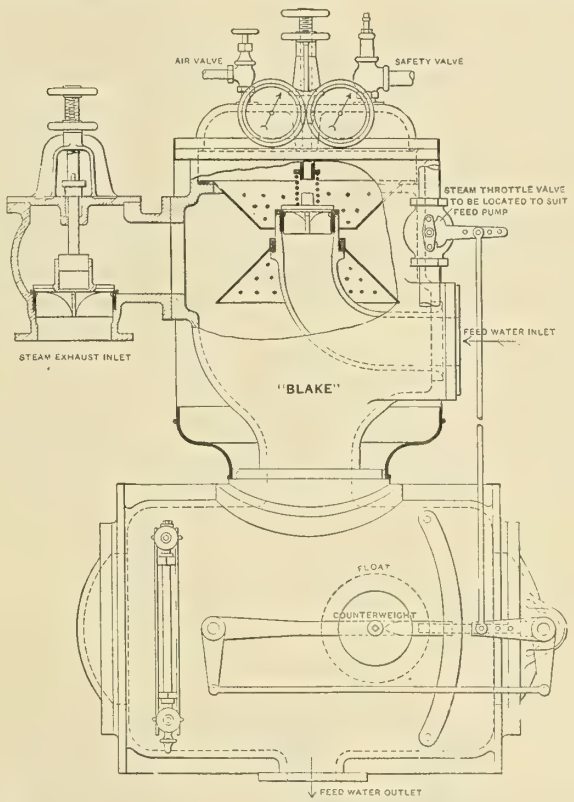


Fig. 13.—Typical Marine Feed Water Heater (Open Type)

water in passing through the seat impinges upon the valve disk at an angle. The valve is balanced by means of a hydraulic step produced by the balancing arrangement, so that the water, coming in at an angle, will cause the valve to turn.

In recent years rolled monel metal has been substituted for tobin bronze for pump piston rods and is now being extensively used for water and air cylinder linings. The material is particularly suitable for this service on account

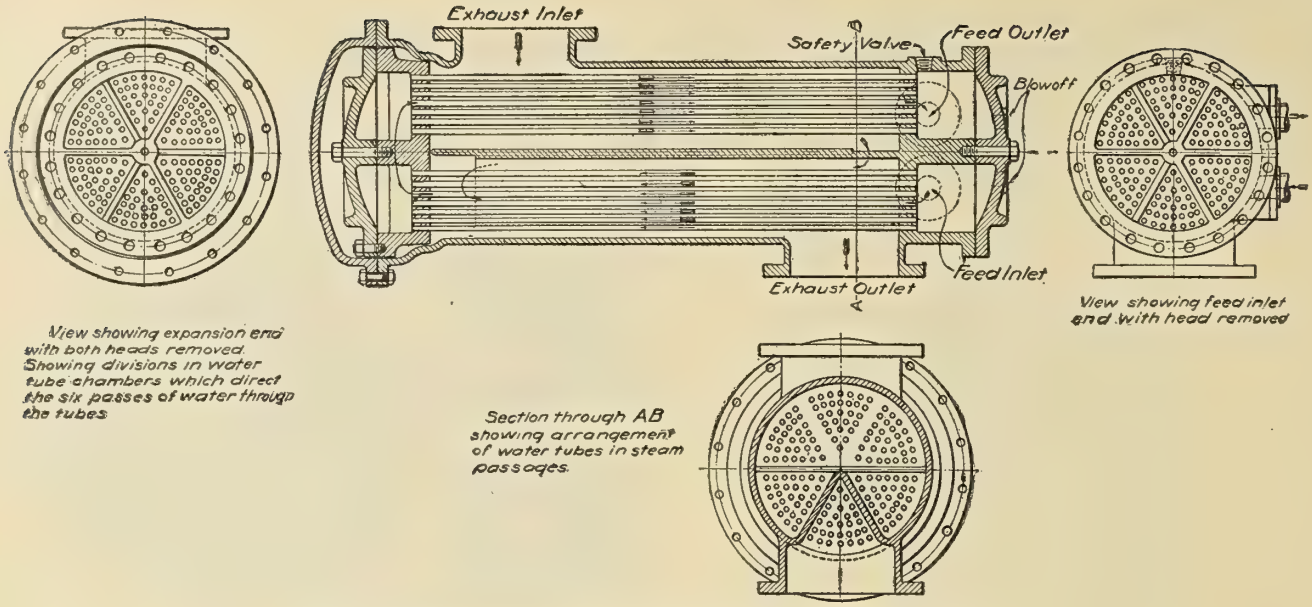


Fig. 14.—Blake-Knowles Multi-Current Horizontal Feed Water Heater

of its high tensile strength, toughness and its ability to withstand the corroding action of acid and alkali waters.

Centrifugal pumps for boiler feeding have been built in various types. The latest arrangement is a turbine-driven set and for certain conditions of installation is very well adapted to the service. Pumps of this type with the continuous flow eliminate in a great measure the pounding through the valves, piping and checks, although the same results can be accomplished by the proper use of air chambers on long-stroke vertical simplex pumps.

Heating feed water for marine installations is rapidly becoming common practice, not only for the advantage of obtaining fuel economy but also for the prevention of boiler strains, which rapidly deteriorate and reduce the life of the boiler. The heater shown in Fig. 13 shows the typical marine heater, which has met with great success in all types of vessels. Its simplicity of operation is clearly illustrated in this cut, and it is noted that it is of the open type, where the steam and water are in direct contact. Another type of common feed heater for marine installations is the multi-current horizontal or vertical types, as shown in Fig. 14. As is clearly shown in the illustration, this heater is of the six-pass type, which guarantees a maximum degree of heat in the feed water to a minimum amount of steam used. This type of heater is strongly recommended for use where the heating steam is the exhaust from auxiliaries in which lubricants have been used in the steam cylinders.

The undesirability of using salt water in boilers requires the installation of some form of evaporator and distiller for making up the feed water losses. One of the latest designs of modern evaporators is shown in Fig. 15, which, when combined with a distiller, makes an extremely economical unit. All internal parts which gather the salt

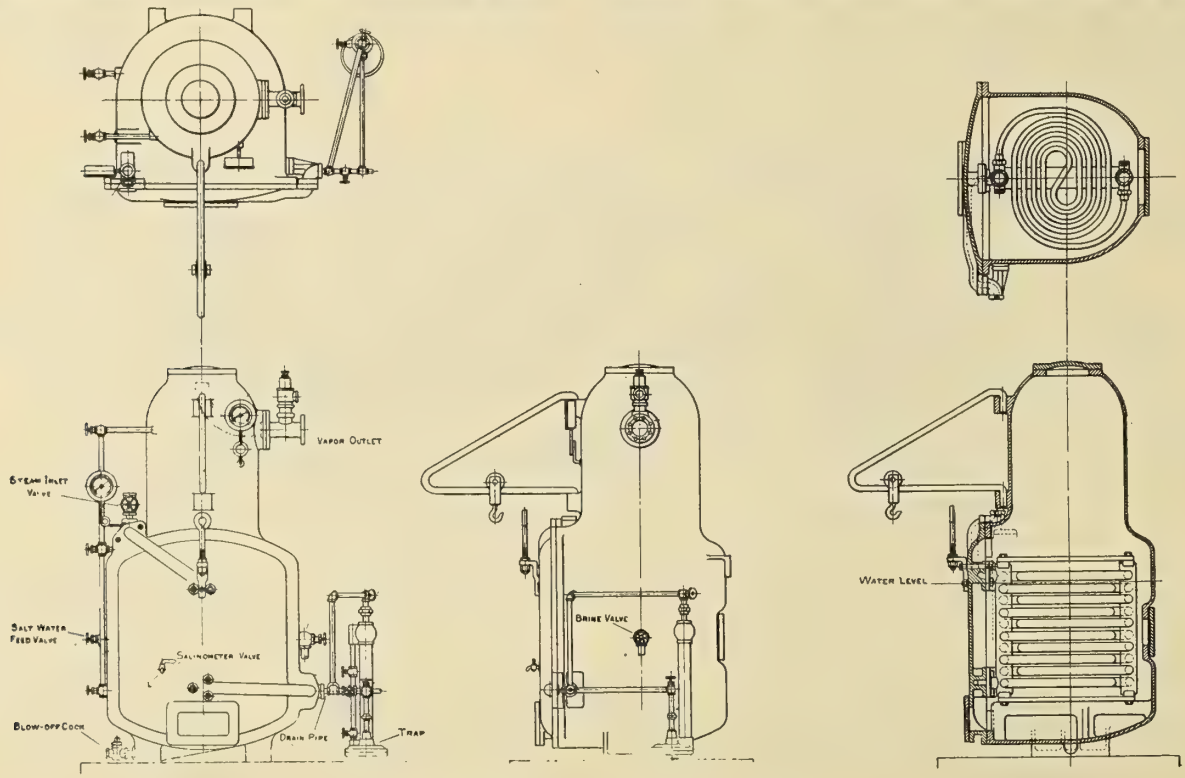


Fig. 15.—Blake-Knowles Salt-Water Evaporator

water scale can be swung out on an arm so that easy access is offered for the proper cleaning of the tubes. The distiller is made either in the form of a two-pass condenser or, better still, by using the six-pass multi-current condenser similar to that shown in Fig. 14.

Great strides have been made in late years in the use of high-vacuum systems and the auxiliary machinery required to produce these vacua. The latest development is the wet and dry system, commonly known as the "twinplex." In form it is much like the well-known twin-beam air pump, except that one side handles water vapors only

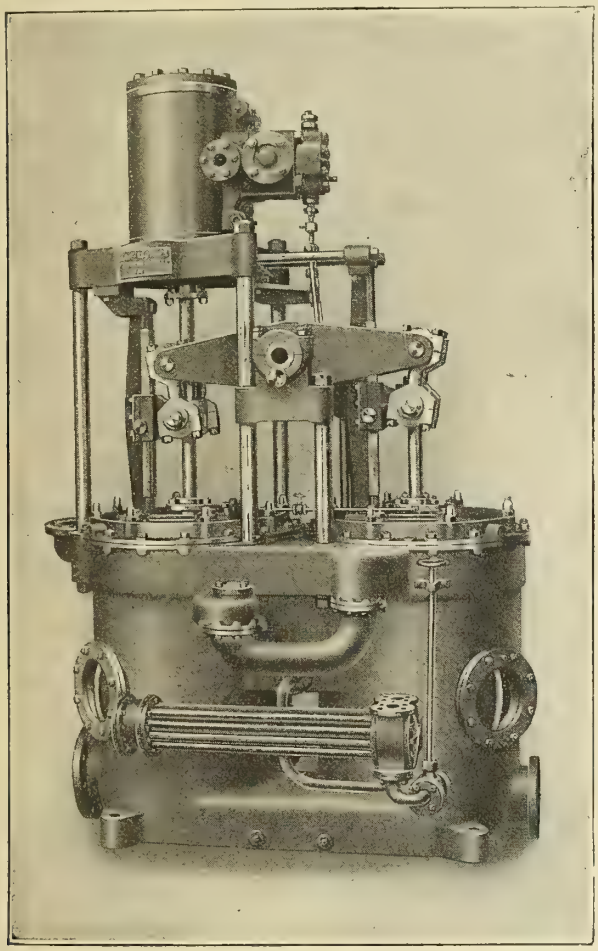


Fig. 16.—Blake-Knowles "Twinplex" Pumps for High-Vacuum Systems

and the other side takes care of all dry vapors from the condensers. The further advantage obtained by the use of the "twinplex" system is that the dry cylinder exhausts under the head valves of the wet cylinder, thus always maintaining a high vacuum in the dry cylinder clearance space and thereby making it possible to produce a higher over-all vacuum in the condenser. This type of air pumping system is equivalent to a three-stage machine and requires a condenser designed for the purpose. It also provides means for the reduction in temperature of the dry vapors and therefore their volume, which is essential to the production of the high vacuum.

Fig. 16 shows the latest type of "twinplex" pump, such as is being installed by nearly all marine high-vacuum systems, both for naval and merchant service.

Future development will undoubtedly be along the lines of greater steam economy. This may be accomplished in two places: First, by the use of vertical direct-acting, long-stroke cut-off pumps or by the use of high-speed, turbine-driven centrifugal units, each of these types having its proper place, depending upon the particular installation. Second, by the use of high vacuum systems with the proper care given to the design of the condenser and air pump units.

Marine Engineering at the Naval Academy

BY D. G. VAN DE WATER*

THE subject of marine engineering is covered more thoroughly in the four-year course at the United State Naval Academy at Annapolis than in any other institution of its kind or character in the world.

The course is under the direction of the Department of Marine Engineering and Naval Construction and the first year's work is devoted to the study of the "language of engineering," line drawing, descriptive geometry, engineering and mechanical drawing. This is followed in the second year by the assembling and disassembling parts of completed drawings. During the second term of this year the midshipmen make a thorough study of mechanical processes and have courses in shop work practice and metallurgy. A member of this class has instruction in the pattern shop and works in the foundry while he studies the forms and molds for, and makes castings of, various metals. He studies the various processes of abstracting metals from their ores and works in the blacksmith shop, machine and boiler shops, making a general study of boilers and reciprocating engines.

The first half of the third year is devoted to a thorough study of marine and naval boilers of all types, together with their fittings and accessories. The care, management and testing of boilers is part of the instruction in this term's work. During the second part of this year the midshipman is given a more detailed course in naval and reciprocating engines and auxiliary machinery, studying the theory and practice of taking indicator cards and of determining brake and shaft horsepower. He studies propulsion, especially as applied to screw propellers. The operation and management of fire and boiler rooms, with the naval regulations concerning them form part of this term's work and is followed by a practical study of internal combustion engines.

During the first half of the fourth year the midshipman's time is devoted to a study of the principles of naval architecture and their application to the construction of the types of vessels of the United States Navy. Numerous sectional models, as well as operative models of appliances and installations generally, are empoyed in this course. The second term of the final year is applied to the study of turbines, their principle and operation. Included in the laboratory equipment are extensive turbine installations providing for the practical application of the theory involved.

The Naval Academy's equipment for all this work is exceptionally fine and is housed chiefly in Isherwood Hall, a model plant, named for the renowned Engineer-in-Chief of the Navy during the period of the Civil War. In this building are models of various types of dry docks, a complete set of torpedo-boat engines, various makes of turbines and ice machines. There is an entire room devoted to internal combustion engines. Every type of auxiliary and fitting and casting used aboard ship is to be found in this building, as are also many models worked by steam and compressed air; all the different makes of boilers, ship forms and structures, and models of warships. In Isherwood Hall there are are also machine, woodworking and blacksmith shops, a foundry, an assembling room and a splendidly equipped drawing room.

* Midshipman, United States Naval Academy, Annapolis, Md.

Forced Lubrication for Marine Turbines*

Combined Gravity and Forced System Designed to Meet Requirements of Single Screw Cargo-Carrying Steamers

WITH the more or less general adoption of geared turbines to all classes of ocean-going vessels, in most of which, unlike the navy, there are only two engineers on watch, it has become necessary to give the subject of lubrication considerable thought, with a view to obtaining a degree of simplicity and dependability which will reduce attention and anxiety to a minimum.

When considering the adoption of any particular system it must be borne in mind that no hitch should be possible which might in any way make it necessary to stop the turbines, otherwise, under difficult sea conditions, results might be disastrous. To meet such a condition, all important fittings which in themselves could obstruct the passage of oil must be supplied in duplicate, or be capable of being by-passed and be easy of rapid overhaul.

As every trade route has its own conditions to meet, it is impossible to describe a system suitable for every class of ship, but it is proposed to describe a system which will meet the requirements of many single screw cargo-carrying vessels, and which can be modified to meet special conditions, arising from long voyages, tropical waters, etc.

A combined gravity and forced system offers the greatest advantages, and consists simply of a pump taking oil from a drain tank and discharging it through a cooler to a gravity tank, from which it falls to the turbine bearings, etc., and back to the drain tank; or can be by-passed, in which case it does not enter the gravity tank, but is forced direct to the machinery.

The following main fittings would be required for such a system, and are stated in the order in which the oil would pass through them, when traveling from the drain tank to the turbine. One drain tank, two oil strainers (one for each pump); two pumps (one working and one stand-by); one oil cooler; two gravity tanks, and one combined oil distributor and water and sludge collector. There are many small fittings of a more or less essential character, and these will be dealt with in describing the above main fittings.

The drain tank should be of sufficient capacity, when full, to supply oil for fifteen minutes, assuming none is returning to the drain tank; or, in other words, the oil should be travelling four complete circuits in an hour. The tank should be a self-contained unit placed in a cofferdam in the double bottom rather than built into, and forming part of, the double bottom, and should be easy of removal for examination. The top should not be less than 6 inches below bottom of the gear case to ensure a ready drain, and not less than 3 inches above double bottom tank, to clear bilge water. In addition to the drain and suction pipe connections, a float level indicator must be fitted so as to be easily observed from the starting platform, also an air pipe and manhole.

The oil strainers perform an important duty and deserve attention in design. The body may be of cast iron, having a cover easy of removal, to enable inspection and cleaning of the straining grid. The grid may be a gunmetal casting or a steel tube perforated with holes, say, 1 inch diameter, and in either case the area through grid should be about ten times that of suction pipe. A suitable straining medium will be found in 24-mesh wire gauze, this to be properly secured to the grid. The gauze will reduce the effective area through grid by about half. The strainer should be in an accessible position, and have the cover on top to avoid overflow of oil when cleaning.

The pumps are made by specialists and need no particular description; however, they should be ordered of ample capacity and be fitted with a valve or cock on discharge, and suction branches for isolation purposes in case of overhaul at sea. For guidance purposes the speed of oil through discharge pipes may be taken at 200 feet per minute for pipes 3 inches diameter and above.

The oil cooler calls for special attention, particularly when the vessel passes through tropical waters. It may take the same form as a steam condenser, with similar tubes and packing, but with the water circulating around outside of tubes, with preferably a four or six flow to insure good circulation. This plan has been largely adopted, but it is economically impossible to render the flow of the oil turbulent, and the rate of heat transfer is accordingly low. Even viscous fluids, however, will not maintain the laminar character of the flow around a sharp corner. Hence certain firms construct their coolers in a different way. The water is passed through the tubes and the oil outside. Numerous baffles are fitted to cause the oil to flow up and down in zigzag fashion across the cooling tubes, and at each abrupt change of direction a certain disturbance is produced in the laminar flow of the oil, which facilitates the interchange of heat. At present knowledge of oil coolers is in its infancy, and there is much room for research and careful design. It is desirable to fit thermometer pockets on oil and water inlet and outlet. The present practice admits of oil discharging to turbines at 80 degrees F., and leaving turbines at a maximum of 120 degrees F. The cooler should be easily accessible and have a by-pass fitted.

Each gravity tank should be of equal capacity to the drain tank and be fitted with cocks to enable either tank to be in circulating use while the other acts as a settling tank. These tanks must be placed high enough to give a gravity pressure of at least 10 pounds per square inch, and should be fitted with gage glass and float indicator with wire leads and gage board arranged to enable the level to be observed from the starting platform. A manhole, air pipe and overflow pipe must be fitted, the overflow pipe being led back to the drain tank or reserve oil tanks. As previously mentioned, a by-pass is fitted between the pump and the gravity tank to enable forced lubrication to be applied to the turbines without the oil having to pass through the gravity tanks.

The combined oil lubricator and water and sludge collector need be nothing more than a cylindrical casting of sufficient depth to admit of water and sludge gathering at the bottom, while oil flows out at the top to the bearings and gear sprayers. It is desirable to fit separate connections from the distributor to the bearings and gear sprayers, with a controlling valve at each, as an adjustment is thereby easily effected whereby the bearings and sprayers will each receive their proper share of oil. A water draw-off cock placed about 12 inches from the bottom and a door for removal of sludge are to be provided.

Having covered the main fittings, a word or two on the turbine fittings might not be out of place. Control valves

* From *Engineering*.

on each turbine bearing are unnecessary, provided the pipe arrangements are such that all bearings get an equal chance. To ensure this, pipes should have easy bends and branches on pieces be given direction with flow of oil. Means of testing the flow to bearings must be provided, and may take the form of a sight glass placed in the line of pipe, or of a test cock on the high pressure side of a bearing, having a visible flow to the drain side. As an extra precaution pressure gages may be fitted on the pressure side. The gearing sprayers should each be fitted with a guard cock having a locked-open arrangement.

The pipes and fittings should be tested to 50 pounds per square inch, with the exception of the tanks, for which a 5-pound test is sufficient. A relief valve should be provided near the pump set to blow-off at 50 pounds per square inch, having an outlet led to the pump suction. The pipes may be of steam-quality iron, with the exception of the small sizes, where it will be found cheaper and more convenient to fit copper pipes with nipples. Great care should be taken in shops to clean out turbine, gear case and other castings thoroughly. A steam jet will be found a convenient means of removing all traces of sand and other foreign matter, while linen makes a good finishing-off cloth. Cotton or other waste should not be used, as much trouble has sometimes arisen, due to the strands of thread, etc., left on the castings. It is impossible to lay too much stress on the importance of this necessity for thorough cleaning.

It will be noted that nothing has been said regarding the water circulation to the oil cooler; this can be arranged as desired, but a separate pump is undoubtedly best, with a stand-by connection from main condenser circulating pump. If this latter is fitted, a good circulation is obtained by leading the discharge from the cooler to the main circulating pump suction. Should a separate overboard valve be fitted, it must not be placed higher on the ship's side than the main circulating discharge, otherwise the heads are unequal and the cooler might suffer accordingly.

The system described is a simple one, with as few complications as possible, and can be adapted to most vessels. It has been pointed out in some quarters that particles of metal from the gearing mix with the oil and gradually work their way into the bearings, with bad effect. To avoid this, separate systems have been fitted, one to the turbine bearings, and the other to the sprayers and gearing bearings, it being necessary to combine the two latter, due to the drain being a common one into the gear case. It is very doubtful if such a partial correction is worth all the duplication of working parts necessary to carry it out, and it is also doubtful if with good quality of gearing and reasonable changes of oil any trouble may be expected from the bearings.

Marine Lubrication—Twenty Years' Progress

Animal or Vegetable Oils Superseded by Combination with Mineral Oils—Forced or Positive Feed Now Supplanting Wick Oiling

BY W. F. PARISH

BEFORE the advent of mineral oils marine engines were lubricated with sperm oil or whale oil, or by a vegetable oil such as rapeseed or olive oil, and in some cases with lard oil. Many of the marine engineers to-day tell stories of the great satisfaction that they had twenty years or so ago, when the above-mentioned materials were used, and they seem to regret very much that the prices of these oils make them commercially impossible as lubricants for this very extensive class of service.

We know to-day that these animal or vegetable oils have certain fundamental defects when used for the lubrication of machinery. Invariably, due to heat generated in the bearings and to oxidation, these oils will throw out a free, fatty acid which attacks the metal, causing pitting and corrosion, which, however, is never very much in evidence while the same character of oil is being used.

The gradual increase in price of these oils, due to their constantly decreasing production, made it necessary to look for other material. At first mineral oils were combined with various proportions, generally very large, of some of the animal or vegetable oils. There is a rather peculiar, well-grounded condition in regard to marine lubrication that does not exist in the lubrication of any other class of machinery; that is, the oil used must saponify when working with water. All of the animal and vegetable oils formerly used would form soaps on the guides and in the bearings when worked with water, and it was considered absolutely necessary to have oil that would act in this manner on any bearing or guide when water was turned on it, the reason being, supposedly, that soap would not wash from the surfaces as readily as straight mineral oil. The fact that it seems to be necessary to have an oil that will in some manner form an emulsion if water is used has established the present practice of making marine oils on the basis of a mineral stock compounded with from 10 percent to 25 percent of vegetable or animal oil.

The use of these compounded oils, outside of Government and special service, has not undergone any very great change since the marine practice was first developed. Old wick oilers are still in use, and hand oiling is resorted to as the main feature of lubrication on some vessels, the wick oilers having been taken off entirely on other ships or being depended upon only as auxiliaries. When the time comes in the future for changing over the lubrication of all marine engines to a forced or positive feed system it will then be possible to furnish oils that will be much better lubricants than those now in general use and that can be used with greater economy and with less danger to the operating machinery.

Wick oiling, while still depended upon to a large extent in marine work, is, as a matter of fact, a very unstable and unscientific method, developed largely by the rule of thumb and not subject to any fixed rule. Each wick seems to be an individual unit that varies in its feed according to many conditions not at present well understood. For instance, it is supposed that increasing the number of wicks will increase the amount fed and decreasing the number of wicks will decrease the amount fed. Very careful tests, however, made on a number of ships have

shown that the flow of oil through wick oilers does not conform to this rule, and that under fixed conditions as to height of oil in the manifold, number of strands, and temperature of the oil and the room, plus and minus results are secured without any apparent reason.

Progress in Marine Lubrication

BY D. S. PATERSON*

During the past twenty years rapid strides have been made towards a more efficient lubrication of marine machinery. Lubricating oil has been more generally used owing to its nature being such as to be able to lubricate with a force feed system, and owing to the inability of procuring a grease of such quality and durability as would accomplish the work.

In times past the greases used in the lubrication of marine machinery have been of the common tallow kind, which could not give satisfactory results through inability to stand up under medium temperatures and pressures. As is well known, tallow greases will become rancid by age, owing to the constituent parts breaking up by coming in contact with the moisture and oxygen of the atmosphere. Not only do they become rancid, they also contain acids which corrode and pit journals and bearings. Again, tallow greases will not stand up under the action of water when brought in contact with it. Principally due to these reasons, therefore, the use of grease for marine lubrication has not been so extensive as demanded by the absolute requirements with a grease of the proper quality.

At the present time high-grade petroleum greases are superseding tallow greases for marine lubrication and are rapidly becoming popular because of their superior lubricating qualities. High-grade petroleum grease will hold its viscosity under high temperatures, will not decompose when brought into contact with the atmosphere, water or steam; neither will it deteriorate with age. It can be taken into any climate and it will maintain its original density without loss of lubricating efficiency.

On the other hand, tallow greases, the same as oil, will shirk their work. They flow off the bearings as soon as applied, while high-grade petroleum grease has sufficient adhesive and cohesive properties to remain on the bearings until it is thoroughly used up. Tallow greases under medium bearing pressures have at least 20 percent greater friction load than high-grade petroleum grease. At double the pressure, tallow grease has 107 percent higher friction "load" than high-grade petroleum grease.

The need of a heavier than oil lubricant, which would eliminate the weaknesses of the tallow greases, resulted in the production of lubricating greases, many of which were originally (and still are) but little more than soft soap, with a weight-making and non-lubricating "filler" to give them body. The nature of this "filler" varies, according to the theory of the maker. It may be wax, paraffine, resin, resinous oil, talc, clay, graphite or some other substance, equally worthless as a lubricant; and in most cases positively injurious to the bearings to which it is applied. Not one of these materials will add in the slightest degree to the lubricating efficiency; but, on the contrary, will materially increase the friction load on every bearing on which such a lubricant may be used. Many greases are made wholly or partly from animal oils, which decompose or become rancid, and may be very offensive when kept in a hot engine room. Such greases are generally highly scented to disguise the odor arising from this cause. Oil of myrbane, which smells like almond oil, and oil of citronella are extensively used for this purpose. The failure of such mixtures to give efficient lubrication, and their tendency to increase rather than decrease bearing troubles, has naturally prejudiced many engineers against the use of grease, but since the introduction of high-grade petroleum grease its superior efficiency under all working conditions the year round has been so thoroughly demonstrated that it is generally recognized by consulting and practical engineers as the ideal lubricant for practically all purposes.

The true value of a lubricant lies not only in its capacity for reducing the friction load under moderate and low-bearing pressure, but it is especially valuable and economical when it is capable of developing a low coefficient of friction under severe loads as well. This is especially evident where bearings are burdened with heavier loads than they are usually compelled to carry. It is always poor policy to let "well enough" alone. When there is a tendency for a few bearings to run warm, every effort should be expended to prevent the development of the excessive friction which they are surely carrying. A friction reduction of even a slight percentage through the use of a high-grade petroleum grease will offset the extra cost of the lubricant many times over the decreased fuel consumption.

* Manager Marine Department, Keystone Lubricating Company, Philadelphia, Pa.

Large Fleet of Light Draft Motorboats for Coast Defense Recommended by Naval Consulting Board

The Naval Consulting Board held its annual meeting in New York city on March 10, and at the conclusion of the session issued the following statement: "The Naval Consulting Board wish to say that there is no truth whatever in the report circulated that Mr. Thomas A. Edison has resigned from the board. He was to-day unanimously elected president of the board for life. There was a large attendance, nearly all the members being present. A new committee on metallurgy was appointed with Professor Richards, of Lehigh University, at its head. The subject of submarines received a great deal of attention. Reports were made on methods of improvement of torpedoes and on the development of internal combustion motors, and Hudson Maxim made a report on improvement in methods of constructing large guns. Certain recommendations for important experiments relating thereto were approved. Important reports were made on developing new methods of detecting and locating submarines and defending vessels against torpedo attacks."

The following resolution was adopted by the board: "The Naval Consulting Board at its meeting held in New York on March 10, 1917, is unanimously of the opinion that a large fleet of light draft high speed motorboats, built preferably of wood, because of the opportunity which it gives for quick construction and carrying guns, should be provided at the earliest possible moment for the protection of the coasts and harbors of the United States and vessels traveling thereon."

The board recommended on the report made by Mr. Sprague that the Navy make an investigation and trial of a new type of light mosquito craft. The Secretary of the Navy is co-operating with the board in facilitating the carrying on of certain special experimental work involved in national defence. The Commission of Special Problems has started to make experiments on under water detection by electric, magnetic and electromagnetic means.

Development of American Coastwise Ships

General Characteristics of Coastwise Passenger and Freight Steamers—Application of the Steam Turbine to Express Steamers

THE first American coastwise steamship to be described in MARINE ENGINEERING was the passenger and freight steamer *Princess Anne,* built just twenty years ago at the old Roach shipyard in Chester, Pa., for the New York-Norfolk service of the Old Dominion Steamship Company. The *Princess Anne* was 326 feet 5 inches long by 42 feet beam and 27 feet molded depth. Her gross tonnage was 3,078 and she had a cargo capacity of 150,000 cubic feet on a load draft of 17 feet. Propulsion was by a triple expansion reciprocating engine of 3,500 horsepower designed to give the ship a speed of 16 knots. Steam was supplied at a pressure of 190 pounds per square inch by four single-ended Scotch boilers placed athwartships with a fore and aft fireroom on the centerline of the vessel. Although other vessels have been added to the Old Dominion fleet during the past twenty years, it is significant that generally speaking, with the exception of accommodations and equipment, practically no changes have been made in the design of either the hull or propelling machinery adopted at that time. The regularity of service and economy of operation maintained year in and year out by the vessels of this fleet give some indication of the high standard early attained by ship designers and builders in this country in the construction of a distinctly American type of coastwise steamship.

Representative Types of Vessels

Disregarding vessels of special types for bay, sound and river service, the ships which form the regular American coastwise fleets may be divided into two classes—passenger and cargo steamers and freighters. Except in the case of vessels operated by or in competition with the railroads, the speed of American coastwise passenger vessels has not exceeded 16 knots, while the average speed of the purely freight steamers is from 10 to 12 knots. Most of the vessels have been of the single screw type driven by triple or quadruple expansion reciprocating engines supplied with steam at from 160 to 215 pounds pressure by Scotch boilers operating under natural draft.

Except for the recent introduction of longitudinal framing there have been no radical developments in the hull construction of vessels of this type other than the continual evolution of improved forms of hulls in accordance with the principles established by model tank experiments and the gradual introduction of improvements designed to safeguard the navigation of the vessels. While the nature of the service in most of the coastwise lines is such as to limit any radical development in the size, power and speed of the ships, nevertheless as far as passenger accommodations and equipment are concerned full advantage has been taken of the latest developments to provide every modern convenience and luxury and safeguard for the traveler at sea.

In the case of cargo boats there is a general tendency toward increase of size and capacity and a steady improvement in economy and efficiency of operation. A noteworthy example of vessels of this class is the fleet of the American Hawaiian Steamship Company. This company now operates twenty ships, sixteen of which are oil burning and four coal burning steamers. Among the largest of these are those of the *Kentuckian* class, built in 1912 and 1913 by the Maryland Steel Company, Sparrows Point, Md. They are 416 feet 2 inches long between perpendiculars, 53 feet 6 inches beam and 31 feet 6 inches molded depth, with a gross tonnage of 6,660, a net tonnage of 4,111 and a deadweight carrying capacity of 10,200 tons at a draft of 29 feet 6½ inches. Propulsion is by a quadruple expansion engine of 4,000 horsepower supplied with steam at 215 pounds pressure by three single-ended boilers operated under forced draft.

Turbine-Driven Ships

The first American coastwise steamer to be fitted with turbine propelling machinery was the *Governor Cobb,* a 300-foot vessel of 2,184 tons and 5,000 horsepower built in 1906 by the W. & A. Fletcher Company, Hoboken, N. J., for the Eastern Steamship Company, of Boston, Mass. This vessel was fitted with a three-shaft arrangement of Parsons turbines and Scotch boilers operating under forced draft. In the same year a larger vessel, the *Creole* of the Southern Pacific Company, was built by the Fore River Shipbuilding Company, Quincy, Mass., and fitted with Curtis turbines and Babcock & Wilcox watertube boilers. The *Creole* was a twin screw vessel 440 feet long over all, of 6,754 gross tons. The turbines were designed to develop a total of 8,000 horsepower, but after a limited period of service they were replaced by triple expansion reciprocating engines.

In the following year the triple screw turbine-driven express steamers *Harvard* and *Yale* were built by the W. & A. Fletcher Company for the Metropolitan Steamship Company for night service between Boston and New York. The vessels were 386 feet 6 inches long between perpendiculars and were designed for a speed of 23 statute miles per hour. Propulsion was by Parsons turbines of 10,000 horsepower supplied with steam by 12 single-ended Scotch boilers operated under forced draft.

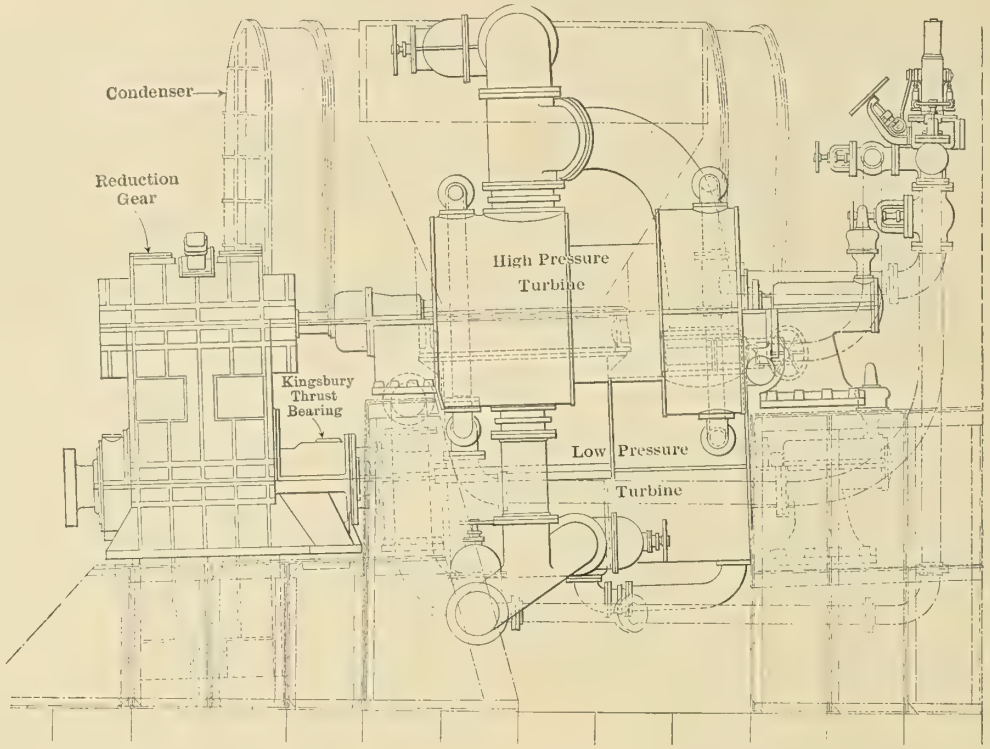
The largest and speediest turbine-driven vessels ever built for American coastwise service, however, were the *Great Northern* and *Northern Pacific,* built in 1914 by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the Spokane, Portland & Seattle Railway Company for service between Astoria, Ore., and San Francisco, Cal. These ships were 23-knot, triple screw passenger and freight steamers 524 feet long over all, of 8,255 gross tons and 25,000 shaft horsepower each. Steam was supplied by twelve Babcock & Wilcox watertube boilers at 220 pounds per square inch pressure, the boilers operating under forced draft.

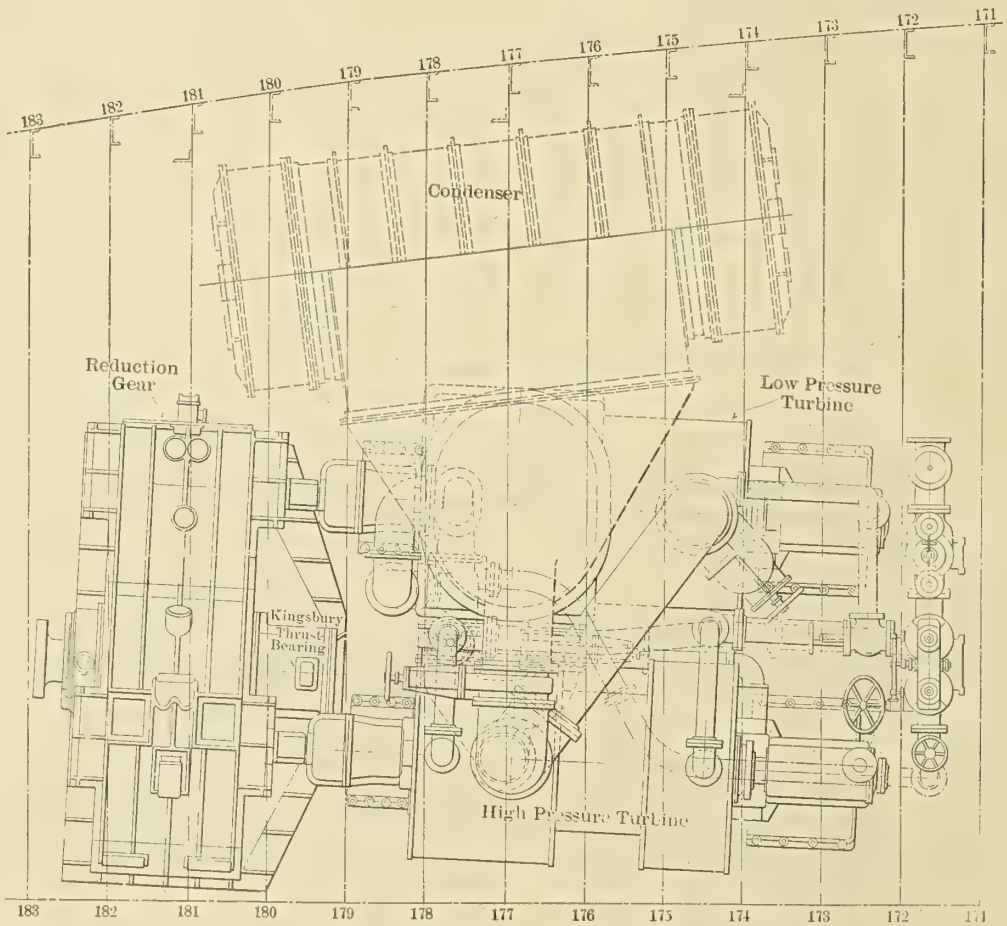
Advent of Geared Turbines

The rather limited application of steam turbines to coastwise vessels was due, of course, to the fact that the direct turbine drive was not adaptable to the relatively low speeds of the majority of these ships. With the recent perfection of the geared turbine, however, it is very probable that turbines will be adopted in a greater number of these vessels. The first large passenger and freight steamship equipped with machinery of this type is now being completed on the Pacific Coast, and details of this machinery, which is designed to develop 10,000 horsepower, will be found in this issue. Notwithstanding the apparent conservatism of American coastwise steamship owners in accepting new developments in marine engineering, it would be difficult to find in any other service more satisfactory records of economy and efficiency than are being made every day by American coastwise steamers.

GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.





Figs. 1 and 2.—Elevation and Plan of Port Propelling Machinery

Geared Turbine Passenger Steamship Maui

Built by Union Iron Works Company of San Francisco for Hawaiian Service of Matson Navigation Company

WHEN the steamship *Maui,* now under construction at the Union Iron Works, San Francisco, Cal., for the Matson Navigation Company, steams out of the Golden Gate she will be the first large passenger steamship to be propelled by geared turbine machinery. A number of single-screw vessels of upward of 3,000 horsepower have used this equipment, but the *Maui* is twin-screw and is rated at 10,000 horsepower. She is designed for passenger and freight service between San Francisco and the Hawaiian Islands and is scheduled to make the 2,080-mile run in 5.8 days. Her length overall is 501 feet; beam, molded, 58 feet, and load draft, 29 feet 11 inches.

The arrangement of her propelling machinery is shown in the plan, Fig. 2, which shows one of the twin units. For each propeller there are two Westinghouse turbines, high pressure and low pressure, which drive the propeller through reduction gears. Each of the two turbines consists of one ahead and one astern turbine, which are mounted on the same shaft and enclosed in a single frame. A study of the plan, Fig. 2, will make this arrangement clear and also show the course taken by the steam through the high and low-pressure turbines while running either ahead or astern. At full power each of the ahead turbines is designed to develop 2,500 horsepower at 2,070 revolutions per minute, so that the total power is 10,000 horsepower. With the same flow of steam the astern turbines will develop 6,000 horsepower.

In order to permit economical operation at reduced power the ahead nozzle chamber is divided into three compartments, two of which are provided with hand-operated valves so that when desired one-sixth or one-quarter of the nozzles can be closed off. The astern nozzles are not arranged in this manner because economy at reduced astern power is of little importance.

The types of these four turbines are as follows:

Turbine	*Type*
High pressure ahead	Impulse reaction
Low pressure ahead	Reaction
High pressure astern	Impulse
Low pressure astern	Impulse

As shown in Fig. 2, in addition to the normal cross compound operation of either the ahead or astern turbines, the steam piping and valves are so arranged that any one of the four turbines can be operated alone in case of emergency. An emergency overspeed governor is geared to each turbine shaft and controls the governor valve in the main steam line by means of a steam relay.

The machinery weights are as follows:

Turbines, with cross-connecting piping and valves	57.5 tons
Reduction gears and thrust bearings	78.0 tons
Condensers and auxiliaries	10.82 tons
Total	146.32 tons
Total weight per shaft horsepower	32.8 pounds

The Turbines

The ahead high-pressure turbine consists of a two-row impulse wheel followed by reaction blading on a drum, while the ahead low-pressure turbine is of the reaction type. The astern high and low-pressure turbines both consist of two-row impulse wheels.

The turbine casings are of cast iron, except the ahead end of the high-pressure turbine casing, which is of cast steel, and the casings are all divided on a horizontal plane.

The turbine rotors and shafts are of cast steel, the impulse wheels being formed integral with the shafts. The impulse blades are of machined nickel steel secured in the rotor by a tongue and groove construction. Vibration of the blades is prevented by the use of tight wedges. The reaction blades are of drawn phosphor bronze secured into

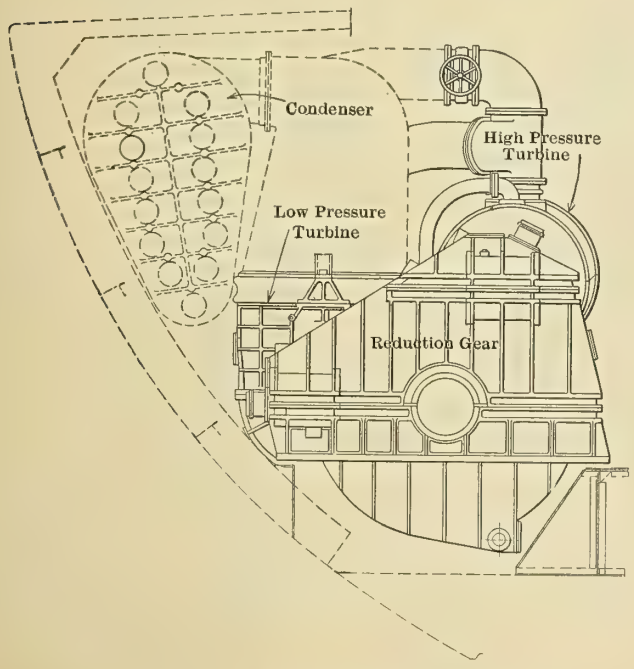


Fig. 3.—Section at Frame 183, Looking Forward

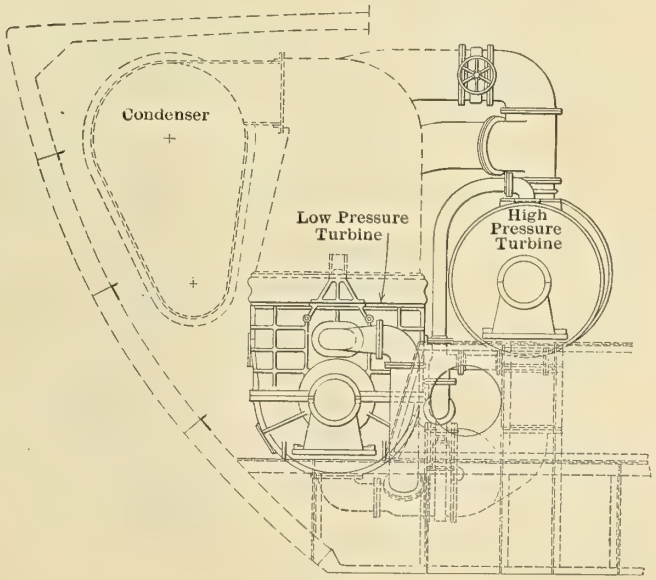


Fig. 4.—Section at Frame 179, Looking Forward

GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.

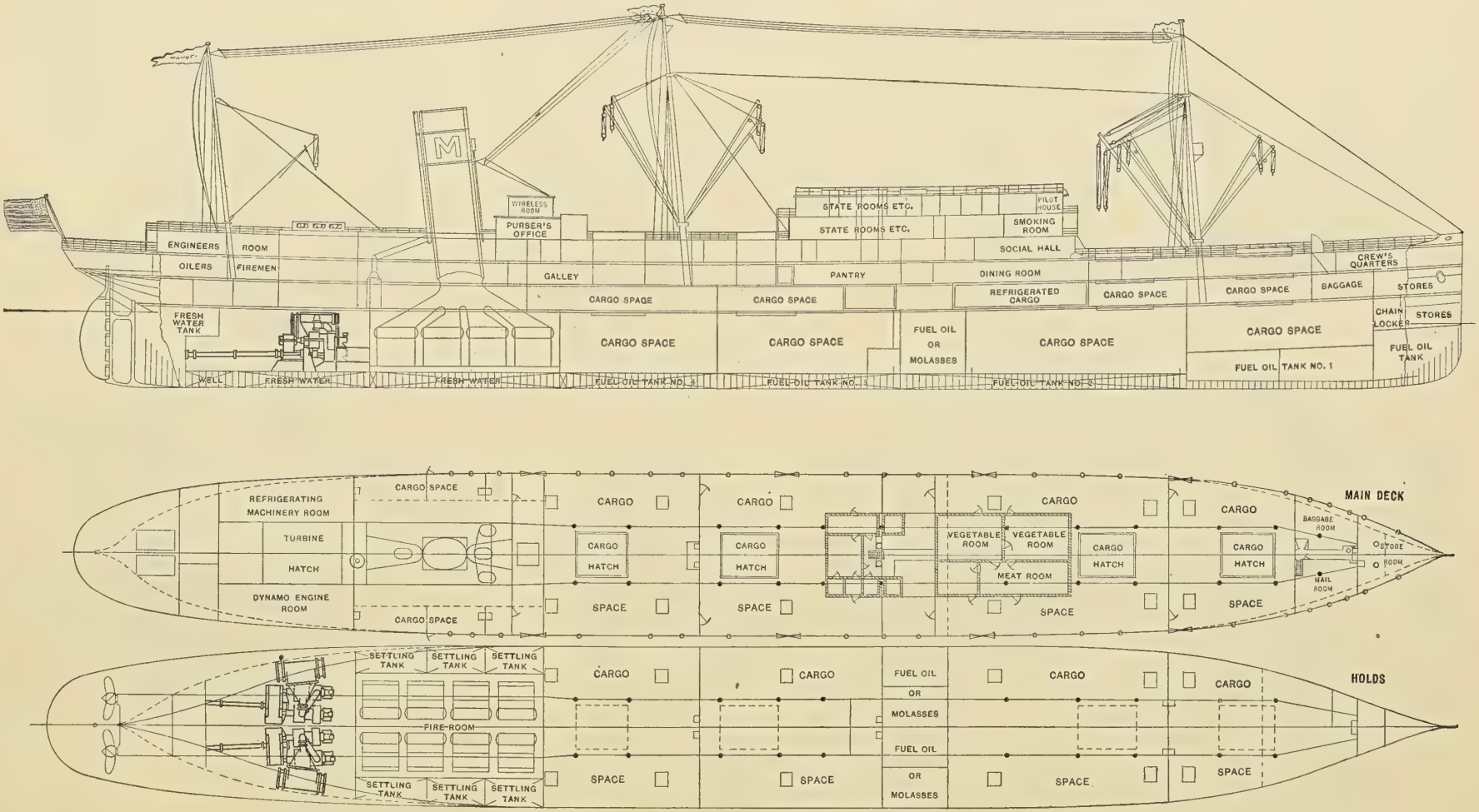


Fig. 5.—Profile and Plans of Main Deck and Holds

GEARED TURBINE PASSENGER STEAMSHIP MAUI

Built by Union Iron Works Company, San Francisco, Cal.

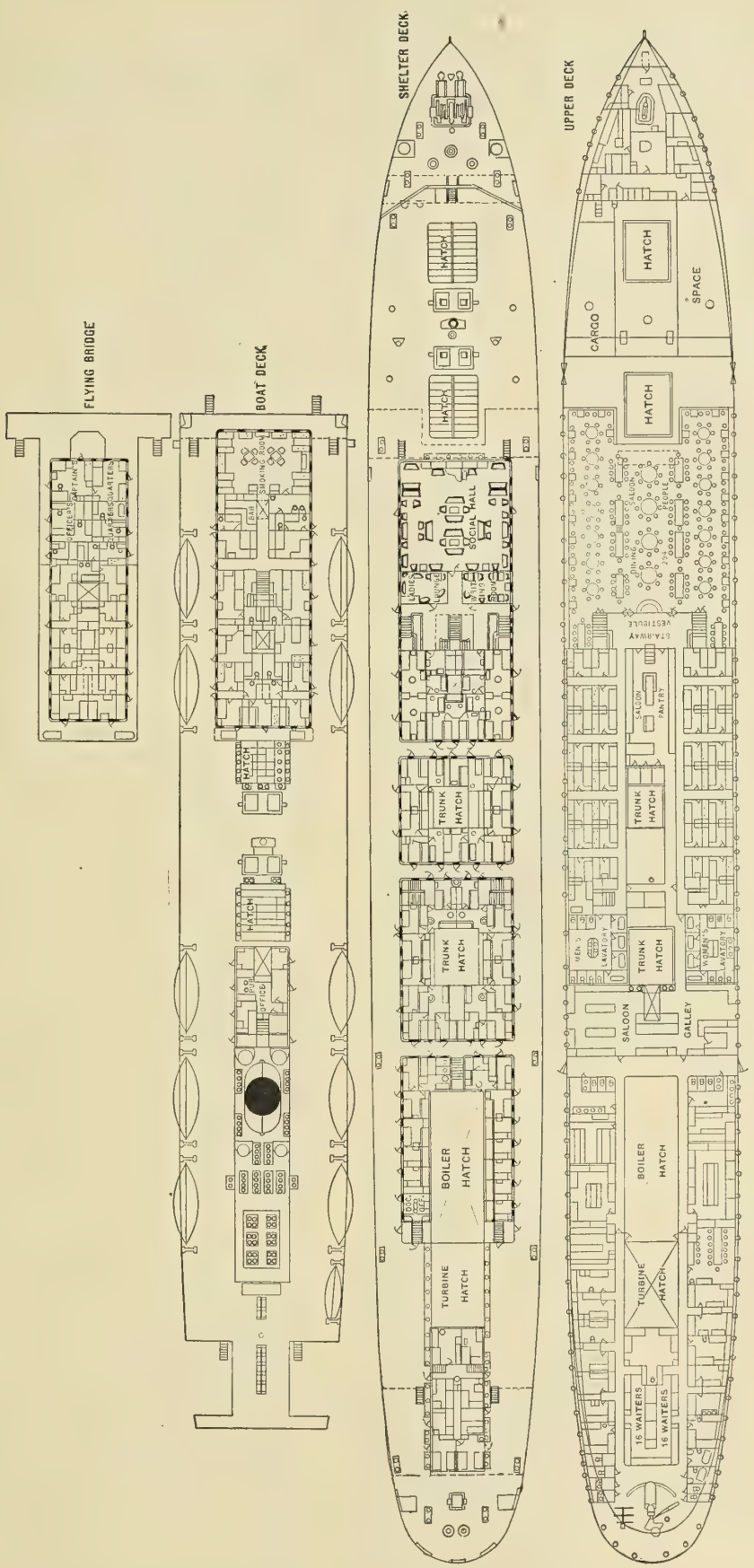


Fig. 6.—Deck Plans, Showing General Arrangement of Passenger Accommodations

dovetail grooves by a positive mechanical interlock between blades, packing pieces and grooves.

In order partially to balance the steam thrust on the drums balance pistons are located at the inlet ends of the high and low-pressure turbines, pipes connecting the spaces behind the dummies with the exhaust from corresponding reaction blading. Between the high-pressure ahead and astern turbines packing of the radial labyrinth type is interposed. In addition to the labyrinth packing the turbine glands are further provided with steam and water seals. The water seal operates on the principle of a centrifugal pump and is designed for use only when the turbine is running from half to full speed; below half speed the centrifugal force is not sufficient to maintain the seal, and therefore from stop to half speed it is necessary to use the steam-sealed labyrinth. Steam is supplied to the glands from the main steam line through a reducing valve which regulates the pressure to about 5 pounds gage. Water is supplied to the glands from a gravity tank, located about 12 feet above the glands, into which the discharge of the condensate pump is led before passing to the feed tank.

The main bearings are of the self-alining type and are provided with pads and liners by means of which the rotors can be adjusted vertically and horizontally. Oil is supplied through the bottom pad and is led up to a distributing groove in the top of the bearing.

The portions of the turbine casings subject to high temperatures are lagged with non-conducting material and the center part of the casing is inclosed in a 1/16-inch sheet metal jacket, which is arranged for removal to give access to the casing joints. All pockets in the turbines and piping are provided with drains which are led into a steam ejector which discharges the water into the condenser, as the latter is located above the drain level. Relief valves are located on the ahead and astern receiver pipes. All pipe connections to the turbines are designed to allow free expansion without imposing stress on the turbine casings. The turbine rotors are tested to 20 percent above the designed full speed, or to 2,400 revolutions per minute.

The turning gear consists of an electric motor, connected to the turbine rotor by means of worm gearing. For lifting the turbine casings and rotors I-beam girders and chain hoists are installed above the turbines and reduction gears, together with special slings and guides for lifting the rotors without injury to the blading.

Turbine Valve Gear and Steam Piping

Admission of steam to the ahead and astern turbines is controlled by two balanced throttle valves, both of which are contained in one body and operated by the same hand wheel. The piping and valves are arranged so that, in addition to the normal cross-compound operation, either the high-pressure or the low-pressure ahead or astern turbines can be operated independently in case of emergency, the turbines being controlled by the main throttle valves in all cases.

The governor valve is of double disk balanced type, operated by two steam relay pistons. The operation of either the high or low-pressure turbine governor will cause the valve to close in case the turbine overspeeds. With this arrangement the turbine is not shut down completely and is always under direct control of the maneuvering valves.

The ahead and astern maneuvering valves are contained in a single cast steel body and are of the balanced single-disk type, with a pilot valve and the valve stem for automatically equalizing the pressure in opening. Springs are provided above the valves to prevent them from chattering in the rush of steam. Both valves are operated by a single hand-wheel and yoke.

Reduction Gears

The purpose of the reduction gears, which are of the Westinghouse double-helical type, is to permit the driving of the low-speed propeller by means of high-speed turbines. They provide a ratio of 15.95 to 1, so that at the designed full speed of 16.5 knots the turbines run at 2,070 revolutions per minute and the propeller at 129.5 revolutions per minute.

Each gear has two pinions, one from the high pressure and one from the low-pressure turbine; and each pinion transmits 2,500 horsepower, so that the total horsepower delivered to each propeller is 5,000 horsepower. Each pinion is carried in a floating frame and is driven by a flexible shaft connected to the turbine shaft by a pin-coupling that permits the pinion to move endwise. Perfect alinement between pinion and gear and uniform distribution of tooth pressure are therefore automatically maintained under all conditions of load.

Incorporated on each of the floating pinion frames is a hydraulic dynamometer by means of which the power transmitted by the pinion can be accurately measured. The pinion journal acts as a pump, and when revolving at full speed supplies a considerable flow of oil under high pressure. Normally the pinion frame is bolted securely to the gear box, but when it is desired to measure the power the bolts can be loosened sufficiently to permit the frame to float on this oil. The gage pressure of the oil under these conditions represents a pressure on the pinion teeth plus the weight of the pinion and its frame. Deducting this weight and multiplying the corrected oil pressure by the pitch line speed and a constant, the total power transmitted by the pinion is obtained. The sum of the power transmitted by all four pinions gives the total power developed, which is a value of great importance in checking the performance of the ship.

Kingsbury Thrust Bearings

The thrust of the propeller is taken by a Kingsbury thrust bearing which is carried in the gear box. This bearing consists of a ring which operates between segmental slippers, made of cast steel and lined with babbitt. Each slipper is pivoted on a hardened seat so that it automatically adjusts itself to distribute the load uniformly over the entire bearing surface. This uniform distribution of the load gives perfect film lubrication and permits the use of a considerably higher unit pressure than is possible in ordinary thrust bearings.

Lubricating System

The lubrication of the main turbine bearings, the gear teeth and bearings is effected by a continuous circulation of oil through a gravity system composed of delivery and return piping, pump, coolers and filter tank. Oil is supplied to the bearings and teeth under a pressure of about 5 pounds from a gravity tank. The oil first passes through a cooler and is then supplied to the bearings and gear teeth, after which it drains back into the drain tank. From the latter it passes into the oil pumps, which discharge it back into the gravity tank through strainers located in the top of the tank.

Boilers

The *Maui* will have eight Babcock & Wilcox marine-type watertube boilers with superheaters and will burn fuel oil. The boiler pressure will be 225 pounds gage and the superheat 50 degrees F.

The boilers have a heating surface of 30,100 square feet and a superheating surface of 3,520 square feet. The fuel oil burning system is of the mechanical atomizing type.

Condensing Plant

The condensing plant consists of a steel plate condenser with a geared turbine-driven centrifugal circulating pump, a turbine-driven centrifugal hot-well pump and two LeBlanc air rejectors for each main unit. The vacuum produced with cooling water at 70 degrees F. will be 28.5 inches referred to a 30-inch barometer.

The condenser is arranged for three passes of cooling water. The condenser heads are of cast iron, the tubes are ⅝-inch outside diameter and are 12 feet long between tube plates, the cooling surface for each condenser being 8,000 square feet.

The main circulating pump is of the single runner slow-speed type as designed for high efficiency, and is driven by a geared turbine unit, the revolutions of the pump being 390 and of the turbine 5,836. These speeds give a high efficiency for both pump and turbine, which results in a very economical unit. Each pump has a capacity of 9,200 gallons per minute and requires 105 horsepower. The pump has a cast iron body and a double-inlet bronze runner. The glands are packed with flax packing and are provided with water seals to prevent air leakage. The rotor is carried between two bearings, one on the gear and the other on the pump body.

The gear is of the double helical type enclosed in a cast iron box. A centrifugal governor which regulates the speed of the turbine is driven from the gear shaft by spiral gears.

The turbine is composed of a high-speed impulse wheel with a single row of blades through which the steam passes twice. The shaft is provided with water-sealed glands where it passes through the casing. At full speed the speed of the turbine is regulated by the governor, which operates a balanced valve, but lower speeds are obtained by hand throttling.

The turbine bearings and reduction gear are supplied with a continuous circulation of oil from the main lubricating system, the gear teeth being lubricated by sprays.

There is a condensate or hot-well pump for withdrawing the condensate from each condenser. The pumps are of the centrifugal type and are direct turbine-driven. They are located below the condensers so that the condensate will drain into them by gravity. The condensate is discharged up into a small tank from which is taken the gland sealing water, thence it overflows into the air-ejector tank, and from there passes into the feed tank. The revolutions per minute are 2,500.

The pump is of bronze and is of the single inlet type, with a water-sealed gland to prevent air leakage.

The turbine is of the impulse type with a single row of blades, through which the steam passes twice. The casing is split horizontally and lagged and fitted with labyrinth-type glands. The rotor is carried in two ring-oiled bearings. The speed is regulated by a centrifugal governor, mounted on the turbine shaft, which operates a balanced throttle valve.

Westinghouse-LeBlanc air injectors are provided for withdrawing air from the condenser. For each condenser there are two ejectors, one being sufficient for full-load requirements and the other being provided as a spare. The air is withdrawn by multiple jets of steam in series which compress the air to atmospheric pressure. The mixture of air and steam then passes into the air-ejector tank, where the steam is condensed and the air escapes to the atmosphere. The air ejectors are made of bronze, and the tank of cast iron.

Auxiliaries

The auxiliaries include a Reilly evaporating plant of 25 tons per day capacity, three 10-ton Brunswick refrigerating machines, two 30-kilowatt and one 50-kilowatt electric generators which supply direct current at 110 volts, a Hyde anchor windlass, a Brown steering gear and nine steam cargo winches, together with the usual equipment of pumps and small auxiliaries.

The Pneumercator

The Pneumercator is an instrument of precision, which, installed in a ship, indicates the fore and aft drafts and registers the mean draft and corresponding tons displaced. It weighs cargoes and bunkers, and other models indicate the level of liquid in and the weight or volume of the same in any tank—afloat or ashore. Both types of instrument are practically foolproof, as there are no floats, diaphragms, electrical connections or other delicate parts to

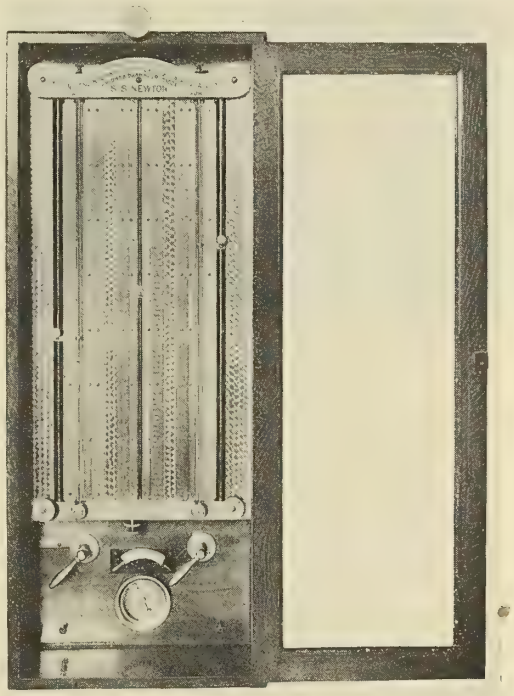


Fig. 1.—Model D-I Pneumercator

care for or repair, and the instrument itself provides means of proving absolutely the accuracy of its readings.

For centuries the draft of ships has been recorded in the same manner—viz., by the crude method of reading markings on the outside of the hull at the bow and stern of the vessel. These readings are then added together and the total is divided by 2. This figure, supposed to be the mean draft, is then applied to a scale furnished by the builder to ascertain the tons displaced. It will readily be seen that the determination of tons displaced in this manner can never be more than a guess. This in itself is the best proof of the need of a better method.

Every year emphasizes more and more the demand for unfailing, automatic accuracy. It was only from lack of a scientific, accurate, reliable, practical instrument that no improvement in recording the draft of ships has been made—until the advent of the Pneumercator. It is possible to tell time by the position of the sun, and, better still, by a watch. But mariners and scientists rely on chronometers. There is the same difference in accuracy between

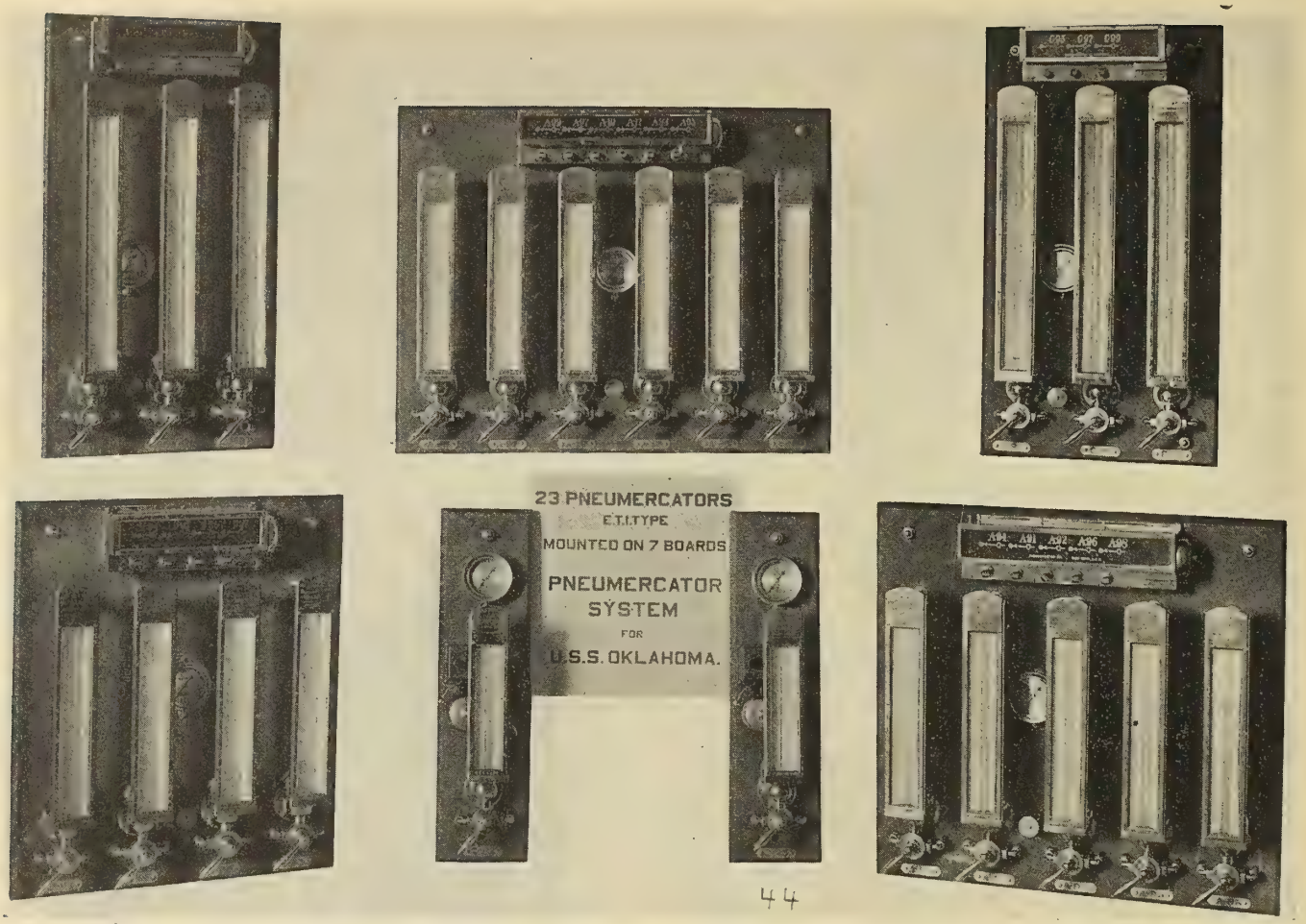


Fig. 2.—T-I and E-T-I Pneumercators Installed on United States Battleship *Oklahoma*

reading the draft of a ship by the old-fashioned gage marks and by the Pneumercator.

The Model D-I Pneumerator (Fig. 1) installed in the pilot house or chart room of a vessel is guaranteed to indicate the fore and aft drafts to within one inch and to register the mean draft and corresponding tons displaced to the same degree of accuracy. Between two successive readings of this instrument the amount of bulk cargo put in or taken out of a vessel can readily be ascertained.

In addition to being an adequate weighing device, it works equally well as a navigating instrument, as the captains knows at all times the list, trim and draft of his vessel, thus enabling him to navigate in shoal water, as well as trimming his vessel to an even keel at sea, preparatory to entering a canal.

The T-I and E-T-I Pneumercators (Fig. 2) are designed to indicate the depth and volume or weight of any liquid or semi-liquid contained in tanks either ashore or afloat, and it makes no difference whether the tank is under pressure, under vacuum or open to the atmosphere. Fig. 2 shows the instruments installed in the United States battleship *Oklahoma* to measure the fuel oil in her double-bottom tanks. These instruments furnish a perpetual inventory of the contents of the tanks—an absolute check on deliveries or withdrawals.

In an article on this very useful invention in the May issue of the *Journal of the American Society of Naval Engineers* H. B. Gregory says:

"The results obtained by the installation of the Pneumercator on the United States battleship *New York* are most gratifying. Not only has it been possible to ascertain, with accuracy at all times, the quantity of fuel in the various double-bottom tanks, but a record of the oil burned on any run has been readily obtained, and with a degree of accuracy heretofore impossible, by merely taking the difference of the gage readings at the beginning and the end of the run. Reports from the vessel on the operation of the instrument pronounce it entirely satisfactory."

Pneumercators are sold by the Pneumecator Company, Inc., New York, and many of these instruments have been, or are to be, installed on many of the vessels of the United States Navy, as well as on the vessels of numerous steamship companies.

First Portable Drill and Reamer for Marine Work.—What is believed to have been the first portable combined auger, drill and reamer ever used in marine work was built by A. Malone at Garden Island, Ontario, in 1865, and used in shipyards on the Great Lakes. The device consisted of a series of sections which could be manipulated like a folding rule with belt-driven pulleys on each joint, the auger or other tool at one end and power furnished at the other end by a donkey engine. This unique device had a working radius of about 30 feet, and would bore about twenty holes to the old hand auger's one. The application of this portable idea to the operation of drilling, reaming and grinding, of course, was rapidly extended with the introduction of small electric motors, so that to-day there are available a great variety of reliable portable electric tools which are being effectively used in shipbuilding operations. Either in shipyards or on board ship where there are holes up to 2 inches diameter to be drilled or reamed or light grinding to be done such tools are found to be indispensable.

Development of American Oil Tankers—II

Vessels Built Since 1901—Freight Steamers Converted Into Oil Tankers—Increasing Size and Number of Oil Tankers

BY J. H. MORRISON *

The total number of oil tankers in service in 1901, exclusive of the Russian oil steamers, was about 160. Of those engaged in trade to the United States there was the Deutsch-American Petroleum Company, with sixteen steamers; the Anglo-American Oil Company, with fifteen steamers; the Shell Transport Company (British), with five steamers; the American Petroleum Company (Dutch), with nine steamers; Hunting & Sons (British), with seven steamers; Bear Creek Oil Company, with four steamers; European Petroleum Company, with four steamers; and Lane & McAndrew, with three steamers, making sixty-three steamers in all, of a gross tonnage of 225,100 tons.

Among the steamers that were early converted to oil tankers (1901 and 1902) were the *Catania,* of 2,600 tons, built in 1881 in England for the Guffey Petroleum Company; the *City of Everett,* a whaleback, of 2,600 tons, built in 1894 at Everett, Wash., altered for the Standard Oil Company; the *Paraguay,* a screw-propelled boat of 2,627 tons, built in 1900 at Lorain, Ohio, by the Sun Company; the *Florida,* a vessel of 1,600 tons, built in England in 1887 and converted by the Texas Company; and the *Louisiana,* of 2,849 tons, built at Chicago, Ill., for the same company. There were four steamers built at Chicago in 1901 for service between the Northern lakes and Europe, but the business proving unprofitable the vessels were sold to the Texas Company and converted to oil tankers for service on the Atlantic coast. They were named *Northeastern, Northwestern, Northtown* and *Northman.*

Stranding of S. S. Roma

One of the early "converted" tankers was the English steamship *Roma,* that at the time of the Galveston hurricane and flood in September, 1900, was loading grain at that port. The vessel was driven by the force of the wind through a railroad bridge and a county bridge onto a flat where there was but 6 feet of water, and as the vessel then drew nearly 17 feet of water her days of service were supposed to be ended. She remained there high and dry for several months, but later the Saginaw Steamship Company bought the vessel, brought her to Galveston through a ditch that had been dug for her transfer, and later came to New York under her own steam for alteration to an oil tanker. She is still in the same trade for the Union Steamship Company on the Pacific Ocean.

There were at this time a few steamers under the American flag that were chartered by the oil companies for a short period, but little is known of their service, excepting that some became seriously damaged by fire.

The oil-carrying companies now began to make contracts for new oil tankers. The *J. M. Guffey,* of 2,500 tons, built by the New York Shipbuilding Company for the J. M. Guffey Petroleum Company, was completed in the spring of 1902 for the transatlantic service. Some months later the Sun Company placed in service the *Toledo,* of 2,277 tons, built at Toledo, Ohio. About this time the Standard Oil Company contracted with the William Cramp & Sons Ship and Engine Building Company for an oil tanker much larger than the *J. M. Guffey,* being of 4,205 tons and named *Col. E. L. Drake.* At the same time the Standard Oil Company contracted for a similar vessel with the W. R. Trigg Company, of Richmond, Va. The latter vessel, the *Capt. A. F. Lucas,* was not completed for several months beyond the contract time on account of the financial difficulties of the contractor, but after a long delay the vessel was taken to the works of the Delaware River Iron and Shipbuilding and Engine Works (John Roach & Son), at Chester, Pa., where she was completed late in 1904. The J. M. Guffey Petroleum Company had constructed for them in 1903 by the New York Shipbuilding Company, of Camden, N. J., two more steam oil tankers, named the *Ligonier* and *Latimer,* each of 3,737 tons.

Oil Barges on the Pacific Coast

On the Pacific coast oil barges with towing steamers were first brought into service for transportation of oil, then the *George Loomis,* a small steamer of 691 tons, built in 1895, was converted to a tanker, but it was not until 1903 that the first oil tanker was built on the Pacific coast, and this was the *Whittier,* of 1,295 tons for the Union Oil Company. It was late in 1904 when the Standard Oil Company sent four or more of their large tankers to the Pacific coast for transporting oil to the East Indies. Since then the Standard Oil Company, of California, has had a large number of oil steamers in this service, among them being the *Capt. A. F. Lucas, Col. E. L. Drake, El Segundo, Maverick, Richmond* and *Asuncion.*

In 1906 the lake-built frieghters *Minnewaska* and *Minnetonka,* constructed at Cleveland, Ohio, in 1902, were cut into two parts, brought through the canal and put together again, and altered to bulk oil carriers by the Newport News Shipbuilding and Dry Dock Company for the Union Oil Company, of San Francisco. Their names were changed to *San Rita* and *San Maria.* They were each over 5,000 tons. The company sent them to the Pacific coast for service. The Associated Oil Company, of San Francisco, had constructed for them by the former builders the *W. S. Porter,* of 4,900 tons, and the vessel left for service on the Pacific coast with a cargo of oil in October, 1906.

Oil Tankers Built in 1907

The business depression of 1907 affected very largely the transportation of oil in bulk, at the same time as other freights were affected, for we find there were but two steam oil tankers built in the United States in 1907 and 1908—the *Sun,* of 4,836 tons, by the Newport News Shipbuilding and Dry Dock Company for the Sun Company, and the *Texas,* of 5,106 tons, by the Newport News Shipbuilding and Dry Dock Company for the Texas Company. During the next two years but one oil tanker was built in the country, the *J. A. Chanslor,* of 4,938 tons, by the last named builders for the Associated Oil Company, of San Francisco, Cal.

Renewed activity among the oil transport companies in increasing their fleets of bulk oil steamers soon began, however, for in 1911, 1912 and 1913 there were no less than twenty oil tankers in course of construction on the Atlantic coast and Northern lakes. It had taken ten years for fuel oil to pass through the experimental stage before

* Author of "History of American Steam Navigation."

it began to take the place of coal as a fuel for steamers. Eight of these vessels were for the Standard Oil Company, and three were built on the Northern lakes. The next year the largest tanker thus far built was the *John D. Rockefeller,* of 8,374 tons, for the Standard Oil Company, of New Jersey, the dimensions being 458 feet 3 inches by 60 feet by 28 feet 6 inches. The *John D. Archbold,* a similar vessel in all respects, was finished a short time later for the same company. The Gulf Refining Company, successors of the J. M. Guffey Petroleum Company, had during the same year three steamers built at Camden, N. J.—the *Gulf Light, Gulf Stream* and *Gulf Coast,* each of more than 5,000 tons.

Loss of the Oklahoma

It was on January 4, 1914, that the Gulf Refining Company, of Texas, sustained the loss of their largest oil tanker, the *Oklahoma,* of 5,853 tons, built in 1908, when 57 miles south of Sandy Hook the vessel broke into two parts just aft the bridge. The vessel was on a voyage from New York to Port Arthur, Tex., and encountered a rough sea with a heavy wind blowing. Twenty-six of the crew lost their lives.

A great change in the maritime policy of our Government was effected by the act of Congress of August 18, 1914, that removed the restrictions on American registry of vessels, and its enactment no doubt was hastened by the outbreak of the European war, but a few days before. One hundred and forty-eight vessels of foreign construction obtained American registry up to June 30, 1915, and of these 37 were oil tankers. The companies having the register of their oil-carrying vessels changed were the Standard Oil Company, 25 vessels, all were formerly of the Deutsch-American Company; Gulf Refining Company, 1 vessel; Texas Company, 1 vessel; Petroleum Transport Company, of Los Angeles, Cal., 5 vessels; Mexican Company, 2 vessels; Union Steamship Company, 2 vessels; Vacuum Oil Company 1 vessel. The largest of these vessels were the *Coalinga* (formerly the *Pectan*), of 7,318 tons, British, Union Steamship Company, of California; the *Ardmore* (formerly the *Dolphin*), of 7,129 tons; the *Muskogee* (formerly the *Triton*), of 7,224 tons, and the *Standard* (formerly the *Jupiter*), of 10,073 tons.

Tank Steamers Attacked in the War Zone

Three American tank steamers have been attacked during their passage through the war zone in Europe, but fortunately none of them was sunk. The *Cushing* (formerly the *Prometheus,* of the Deutsch-American Company) was attacked by a German aeroplane on April 28, 1915, near the North Hinder Light, off Rotterdam, the Netherlands, in latitude 51 degrees 45 minutes north and longitude 2 degrees 30 minutes east, but came off without serious damage. The *Gulflight,* of the Gulf Refining Company, was torpedoed by a German submarine on May 1, 1915, off the Scilly Islands and, receiving considerable damage, was towed into Scilly. The *Petrolite* (formerly the *Excelsior,* of the Deutsch-American Company) was damaged by shell fire from an Austrian submarine on December 5, 1915, while off the coast of Tripoli, in the Mediterranean Sea, in latitude 32 degrees 23 minutes north and longitude 26 degrees 8 minutes east, but fortunately escaped being sunk.

On November 22, 1916, there were in service under American registry 73 American-built steam bulk oil carriers and 45 foreign-built steam bulk oil carriers. At this time there are under construction and contract in the United States 74 bulk oil steamers, some of them for foreign companies.

The largest bulk oil steamers placed in service since March, 1916, have been the *Charles Pratt* and the *H. H. Rogers,* of 10,900 tons each, built by the Newport News Shipbuilding and Dry Dock Company for the Standard Oil Company; while still later there have been built sixteen of the same type of steamer, the largest of them being the *Astral,* of 8,653 tons, for the Standard Transportation Company, of Delaware; the *D. G. Scofield,* of 8,651 tons, for the Standard Oil Company, of California; the *Royal Arrow,* of 7,794 tons, for the Standard Transportation Company, of Delaware; the *Sun Oil,* of 7,100 tons, for the Sun Company; the *William Rockefeller,* of 7,100 tons, for the Standard Oil Company, and the *Standard Arrow,* of 7,794 tons, for the Standard Transportation Company, of Delaware. The contracts made for new built oil steamers in the last year have been for vessels of increasing dimensions.

Improvements in Life-Saving Appliances

BY A. A. SAWMAN

Standardization of lifeboat dimensions, increased volume of internal buoyancy, heavier and non-corrosive materials, increased scantlings in keels, stems, sterns and hull plating, increased margin of safety in construction and installation of hosting devices, a continuous and efficient inspection constitute the improvements in lifeboats the last twenty years.

These improvements, of far-reaching importance, providing available and seaworthy open and collapsible lifeboats in sufficient numbers to accommodate all persons on board ocean-going vessels, have been achieved gradually. The Inspection Service from year to year has made more and more specific the rules and regulations covering the construction of life-saving appliances. In 1896 these rules covered but 5 pages, as against thirty pages in 1916, specifying the construction of lifeboats from stem to stern into the smallest details, making them uniform and practical.

Through assistant inspectors detailed to the shops of the builders a lifeboat, before it has a right to be called a lifeboat, must now be inspected, measured, gaged and examined at the yard of the builder before a name plate is allowed to go on rating the boat as a lifeboat.

Deep Sea Diving

BY M. A. LAWTON*

Since 1819, when the open diving dress was first used by Augustus Siebe in connection with a pump and helmet for supplying air under pressure to the diver, there have been, with the exception of the use of the closed dress, no very great advances made in this field until some ten years ago. From experiments made during the past ten years by the British Admiralty and the United States Navy, it has been proved beyond any doubt that to reach great depths and return successfully is quite possible.

To make such dives successfully it has been found that the shorter the time the diver takes in getting to the bottom the better, because the body absorbs less nitrogen. Also, if divers would adopt the tables prepared from experiments made in ascending and descending the danger of bends, caisson disease, etc., would be eliminated. For the diver to do effective work he must be supplied at all depths with at least one and one-half cubic feet of air per minute.

Lacing the legs of the dress not only lessens the danger of the diver's falling or being inadvertently blown to the surface, but by increasing his stability enables him to come to an erect position with ease.

* Andrew J. Moore & Son, Inc., Boston, Mass.

Ship Classification and Registry

Origin of Classification Societies — Their Functions and Influence upon Shipbuilding — Relations with Underwriters

BY STEVENSON TAYLOR*

WHAT is the meaning of the term "ship classification" and what are the objects and purposes of a classification society?

Frequently is this query made and it is the endeavor of this article to elucidate as concisely as possible the functions of societies inspecting and classifying the common carrier of maritime commerce.

The primary object of classification societies was the maintenance of a register in which was recorded the principal particulars of each vessel's hull, machinery and equipment, giving the date and place of build, builder, owner and material built of and the assignment of a class designated by a symbol indicative of the strength and general seaworthiness of the vessel for insurance purposes.

Classification Rules

In the course of time it became necessary for classification societies to promulgate rules relating to the structural requirements which if observed in the construction of a vessel would entitle her to be assigned the highest classification. Modern classification rules not only deal with the vessel's hull, machinery and equipment but dictate the strength and quality of the material entering into the construction of the hull, machinery and equipment of the vessel. Classification societies, therefore, are technical bureaus of the highest value to the whole shipping community. Their rules comprise the ideas and knowledge of the foremost men in the professions of naval architecture and marine engineering and their methods encourage developments in structural design.

To obtain a faithful and accurate classification of mercantile shipping it is incumbent upon all registers to employ a large corps of naval architects, marine engineers, inspectors and surveyors, located in all the principal ports of the maritime countries of the world. The office of surveyors is referred to in a register book as early as 1781, but as early as 1768 repairs were superintended by the officers of a classification society. In 1824 appeared the first "Instructions to Surveyors," relating to carrying out rules for classification.

Leading Classification Societies

The important classification societies of the present day are the Lloyds Register of British and Foreign Shipping (commonly called British Lloyds), Bureau Veritas, American Bureau of Shipping, Det Norske Veritas, British Corporation for the Survey and Registry of Shipping, Registro Nazionale Italiano and Germanischer Lloyds.

Lloyds Register of British and Foreign Shipping, being the oldest, is generally considered to be the premier of classification societies. The Lloyds comes from Lloyd's Coffee House, where merchants met daily at luncheon and discussed questions relating to shipping. The earliest printed Register known is dated 1764.

British Lloyds Register as now organized was instituted in 1834. Financial support was given to it by Lloyds and other insurance underwriters, a great amount was subscribed and there was issued the first volume of Lloyds Register of British and Foreign Shipping. There was also issued at this time precise regulations regarding the survey of vessels.

Bureau Veritas was founded in Antwerp in 1828 to acquaint the underwriters with the qualities and defects of the vessels trading to Dutch and Belgian ports. The headquarters of this society were moved to Paris in 1832.

American Bureau of Shipping

The American Bureau of Shipping was established in 1862 under the name of the American Shipmasters' Association, and in 1867 its first publication, known as the Record of American and Foreign Shipping, was issued. The name American Shipmasters' Association was changed in 1898 to the American Bureau of Shipping.

The British Corporation for the Survey and Registry of Shipping was established in 1890. The society was formed as the result of fears lest the granting to British Lloyds Register of the power to fix load lines might operate against the interests of shipbuilders and shipowners. As a result of its influence an addition was made to the Load Line Bill granting the British Corporation the right to establish loads lines the same as given to the British Lloyds Register. From an organization formed for this limited object, the British Corporation developed into a classification society. This corporation has undoubtedly had a very great effect on shipping developments, notably in structural methods and in types of ships.

Influence of British Corporation

The advent of the new corporation gave a great impetus to noteworthy developments in the art of ship designing and construction. The British Corporation thus founded has been remarkably successful and undoubtedly has had its effect in rendering shipbuilding methods more elastic and progressive. At first the naturally conservative instincts of shipowners rendered the progress of the new registry slow, but each year the tonnage built under the new rules has steadily increased.

Registro Nazionale Italiano was formed in 1910 to take over and rejuvenate the Registro Italiano formed in 1861.

Det Norske Veritas of Norway was established in 1864 by the various marine insurance clubs as an economic measure. Prior to this date each club or company had its own staff of surveyors.

Germanischer Lloyds of Germany was organized in 1867 and reorganized in 1889.

From the earliest period of insurance underwriters recognized the important factors of the strength, age and upkeep of vessels in their estimate of maritime risks on hulls and cargoes.

Interests Served by Classification

It will be noted in the brief reference to the classification societies mentioned above that each register had its inception among insurance companies and underwriters. But here it is well to digress for a moment to correct any misapprehension that a classification society serves and conserves only the interests of the underwriter. This is

* President American Bureau of Shipping and president Society of Naval Architects and Marine Engineers.

not so, because it also conserves the interests of the shipbuilder and the owner as well as the shipper.

The shipowner is under no obligation to comply with the requirements of a classification society, but it is much better that he should, because the testimony of a classification society as to the construction and equipment of a ship is a certificate of character favorably considered by underwriters. Lacking such certificate the underwriters are warranted in asking higher rates of premium than when the ship is so provided.

Another important and controlling factor is the competition as freight carriers. Shippers insuring their cargoes naturally seek the vessel which will permit their obtaining insurance at the lowest premium, all other factors being equal.

Classification Symbols

Each society or register has its individual symbol indicating the classification of the ship. For instance, Bureau Veritas has the numerals 3/3—1.1 for the highest classification. The record of American and Foreign Shipping, published by the American Bureau of Shipping, assigns ❖ A—1. British Lloyds class is indicated by the following: ❖ 100 A 1, and The British Corporation for the Survey and Registry of Shipping is represented by B. S. ❖.

It is well to point out here that there is a general misunderstanding of British Lloyds classification. The 100 A 1 of British Lloyds does not, of course, mean one hundred years A 1, but is indicative of the highest classification, and is the symbol which superseded their original A 1. In other words, 100 simply means par.

British Lloyds Register as it exists to-day is a good illustration of the advantages of co-operative effort. It is of interest to practically every class of the shipping community to be able to ascertain the character of a given vessel. This is equally true of all classification registers. For the information of those not fully informed on this subject it might be well to state that there are two great institutions connected with shipping; each working independently of the other, both, however, using the name "Lloyds." One is the great marine insurance combination of individuals known as Lloyds of London; the other is the classification society, British Lloyds Register.

For a number of years British Lloyds Register had practically a monopoly of the classification of vessels upon which insurance would be written at favorable rates. This was true until a short period ago—to be specific, the outbreak of hostilities in Europe, since which time the amount of insurance carried by insurance companies in this country has increased to such an extent that it is no longer necessary to look to London for the acceptance of the risk. This is due to the increase in the number of American insurance companies now taking marine risks and the increase in the lines taken of the older companies.

Increasing Business for American Insurance Companies

A representative of one of the large shipbuilding companies states that out of a total of $6,000,000 (£1,230,000) of builders' risk insurance placed since December, 1915, over 63 percent was placed with American companies and very little of which, if any, was reinsured in foreign companies. This representative expresses the opinion that shortly all American builders and owners will be able to place their entire insurance in this country.

Likewise, classification of a vessel by the British Lloyds Register is no longer a necessary adjunct to obtain favorable rates of insurance. At a recent discussion by marine underwriters on the topic of writing marine insurance in America one underwriter stated that he placed $1,000,000 (£205,000) insurance on each of two vessels in one yard and that it had all been placed in the United States, though a portion of it was reinsured abroad. Another says: "Insurance can now be placed to any amount on the classification of the American Society, the American Bureau of Shipping." A third, a member of one of the largest establishments in the United States for placing insurance abroad, says positively: "A dual survey (that is, for instance, British Lloyds Register in addition to that of the American Bureau) is unnecessary, as an American Bureau Record survey is completely satisfactory for all insurance purposes." A fourth underwriter says: "Not only is insurance on American vessels being taken almost entirely in the United States, but that his firm is now placing here insurance on foreign ships for foreign owners."

To conclude, classification is for the use of all classes of business interested in shipping. Owners can demand that vessels contracted for shall be built according to the rules of the society. Builders, when making a contract to build according to these rules, know just what they have to furnish on all important matters connected with the construction and outfit of the ship. In all countries having classification societies and such organizations of their own, the rating given by these institutions forms the basis of marine insurance of both hulls and cargoes. The record, or register book, of these societies is constantly consulted by marine underwriters the world over for particulars regarding the construction, condition and seaworthiness of the vessels classed. Shippers learn whether or not they may intrust cargoes in certain vessels, and purchasers, by the same record, determine whether to buy or not.

In brief, there is no interest in shipping that cannot be benefited by the classification issued by a recognized classification society, and at this particular period of rapid growth in an American merchant marine there is every reason to believe that the American Bureau will do its part in a thorough and efficient manner excelled by none.

Improvements in Small Tools

In the last twenty years there has been no other product of commercial manufacture that has been improved as much as that known to the trades as small tools, such as twist drills, reamers, taps, cutters, counterbores, etc.

An immense amount of testing and experimenting, at a large cost to the manufacturer, with steels, to obtain the best; with forms of teeth of cutters; the flutes of reamers; the pitch of the twist of drills; the points and webs, as well as the clearance; the clearance, grooves and squares of taps; and the testing of tempers, to obtain the very best results in order to satisfy the new demands, would, if fully detailed, fill volumes, with numerous drawings and much data to illustrate the ideas and forms.

Some of these changes were radical and other changes simply ordinary, but all of great efficiency, as any fair-minded consumer will testify when he knows the greater productive power of his own plant.

The advent of high-speed steel caused a revolution not only in the manufacture of small tools, but in the design and building of machinery to use them. Thus the experiments were necessary to determine the best steels, the best heat treatment, the best forms of tools, and bring about the most efficient results. The result is that the demands put upon the manufacturers of small tools, either carbon or high speed, are so much greater than years ago that the business is almost entirely new. The manufacturer who could not have met or handled the conditions would have been but a memory to-day.

The Part Played by Rivets in Shipbuilding

Materials Specified by American Steel Manufacturers — Shearing Strength of Rivets—Design of Rivet Heads

BY DAVID J. CHAMPION*

ANYONE who has given the subject even casual thought must realize what an important part rivets take in the construction of modern vessels. In the early days ship carpentery was considered one of the desirable trades, and men schooled in it were in great demand. In fastening ship timbers together trunnels, or tree-nails made of green heart or ironwood, were used extensively, so were dowels and copper bolts. Later on wrought iron spikes were used for the same purpose.

Ever since the days of the inception of metal shipbuilding, rivets have played an important part in their construction. First, iron rivets were used, as in those days steel rivets were unknown. Later on, however, steel rivets were substituted very successfully.

In the early days steel plates also were not considered trustworthy for shipbuilding purposes, as in those days it was difficult to procure good open-hearth steel, and the Bessemer was often substituted, but always at a great risk of life and property. On the Great Lakes the older ones among us will remember the sad accidents which befell the steamers *Peter Minch* and the *Western Reserve,* in the fall of 1887, both vessels being lost through the shearing of the rivets or the fracture of the plates used in their construction.

With the progress of time great improvements were made in steel suitable for shipbuilding purposes, and to-day open-hearth steel is considered the acme of perfection. Experience has taught us that the best basic open-hearth steel, or acid open-hearth steel, is what should be used for rivets.

The American Society for Testing Materials, which is an offshoot of the American Society of Mechanical Engineers, has given this subject a great deal of thought and consideration. This society, in conjunction with the American Steel Manufacturers, has placed before the world invaluable data governing the manufacture of steel for shipbuilding purposes. These data are compresenhive and are published with such lavish explicitness that it is hardly necessary to detail the information in this article, but the reader is respectfully referred to the specifications issued by the Association of American Steel Manufacturers, dated April, 1914, and also the specifications published by The Carnegie Steel Company, and other large steel manufacturers, dated January, 1914, all of which are worthy of study by those interested in this direction.

Steel to-day in the shape of boiler plate, bars, shapes or rivets is ideal compared with the product put before the public a quarter of a century ago. Failures in the use of it are now very rare. The steel maker knows how to make it, the workman understands better how to handle it, and there is no question but that their work will come up on final test to their highest expectations. In line with the progress of the age in which we live, more and more is expected of every piece of machinery manufactured, and if it were not for the improvements made in the manufacture of steel it would be a physical impossibility to accomplish what we are achieving to-day.

Perhaps the most important point in connection with ship rivets is the shearing strength. This, in connection with the design of the rivet head, which should fill the hole properly, is of paramount importance to the shipbuilder. The greatest success has been attained with the use of what is known as the pan-head, swell-neck rivet. The great advantage of using this style head for marine purposes is freely acknowledged by all the leading shipbuilders and endorsed by them in their regular practice. These rivets are made to fill holes in *punched plates.* The diameter of the punched hole on the die side is always slightly larger than the hole on the *punched side.* In other words, the *punched hole* is of *conical* shape.

In assembling, the plates are *reversed,* and by the use of swell-neck rivets the holes are completely filled and the production is increased to a maximum, while the loss occasioned by loose rivets is reduced to a minimum.

The strength of the joint is further increased by the use of steel made according to Lloyds, or United States Navy specifications for similar quality of steel, which adds at least 5,000 pounds to the shearing strength and 10,000 pounds to the tensile strength.

* President Champion Rivet Company, Cleveland, Ohio.

Heating of Rivets by Gas and Oil Compared

A test recently made by the Newport News Shipbuilding & Dry Dock Company to check the cost of operating a rivet-heating furnace by gas as against the oil furnace formerly employed showed that more time was required by the gas furnace and the fuel cost was also increased. The results, it is understood, showed that 400 pounds of rivets were heated in the oil furnace in 44 minutes at a cost of 52.5 cents, assuming that oil cost 6 cents per gallon, while the cost of heating a similar quantity of rivets in a gas furnace with gas at 55 cents was 53.6 cents and the time required was 57 minutes. It is stated, however, that the rivets heated in the gas furnace were better than those heated in the oil furnace, as there was practically no scale upon them, while those heated by oil were badly scaled in a number of cases. The gas-heated rivets are said to stay hot enough to drive longer than those heated in an oil-fired furnace, because the former are thought to be heated evenly all the way through, while the oil-heated rivets are extremely hot on the outside but are not hot in the center and thus cool more quickly.—*Iron Age.*

Greasing the Ways for a Launching

Twenty years ago when a ship was launched it was the custom to use plain tallow, put on the ways with a mop and smeared over with soft soap. In cold weather train oil was frequently used, mixed in with the tallow.

The present-day method is to use stearine, which is best heated and applied to the ways, then tallow and launching grease and sometimes lard oil is spread over this mixture. In the earlier period mentioned these refinements were not known, but on account of the large tonnage of the vessels being launched the latter method is safer.

Present Steamship Lighting Compared with That of Twenty Years Ago

First Vessels Lighted with Electricity—Advent of the Tungsten Lamp—Lighting of the Steamship Imperator

BY G. L. SEALEY*

ELECTRIC lighting on steamships has not kept pace with the development of electric illumination in other fields. This may be due to the natural backwardness of the seaman to adopt anything new, or it may be attributed to his desire to retain the old and tried methods of lighting vessels that have been used for long years back. The more progressive companies have tried to keep up with the advances, and, as a result, we find many widely different types of illumination on ships operated from the same ports.

Comparatively modern vessels have been lighted by candles, candle-lanterns, and oil lamps. Many of these systems have been superseded by gas lamps, operated from tanks of compressed gas located on the decks. The advent of incandescent lamps has antiquated gas lighting systems and the latest steamships are equipped with lighting systems comparable with those found in our modern hotels.

Probably the first record of the use of electricity as a means of lighting large ocean-going steamships, is that of the installation on the *City of Bristol,* in November, 1879. About the same time—1881—incandescent lamps were first used on the Cunard steamship *Servia.* These are the earliest reliable records of instances of electric lighting on steamships, although it is very probable that incandescent lamps were used on private yachts some time previous to this date.

For the next few years after the installation of the first lighting system on board ocean-going vessels the progress in this line was rather slow. Typical installations of twenty years ago did not take advantage of reflectors. The old-style carbon filament lamps of about 16-candlepower were used to a great extent. Single units of higher candlepower were not in every-day use at that time and clusters of smaller lamps were used to produce the effect of a large concentrated source. These clusters were generally enclosed in some sort of dome and were supplemented by wall lamps and hanging lanterns. The earlier lamps were all mounted bare, then frosted lamps were used, and later shades were introduced. A large proportion of the bulbs used were round in shape, somewhat similar to the lamps used for automobile service, although larger in diameter. Lighting was done more for business purposes than for the comfort of passengers, and none of the lighting systems was at all elaborate. A large number of small units of low candlepower were distributed throughout the area to be illuminated and the resultant light distribution was neither high in intensity nor entirely satisfactory.

Considerable progress has been made in many respects in the lighting of steam vessels in the last twenty years, but there are still very many examples of rather poor illumination. The unshielded incandescent lamp is still used to quite a large extent, probably because of its ease of replacement and convenience of distribution. However, many shipowners have realized the inefficiency of the older methods of installation and the present-day tendency seems to be towards the adoption of more modern and consequently more efficient units.

The standard 110-volt lamp of either carbon or tungsten filament is used almost exclusively. The tungsten filament construction is a modern innovation, as the first tungsten lamp was manufactured only a few years ago. Higher-wattage lamps with tungsten filaments are now being used and lamps of 250 watts or 500 watts have taken the place formerly held by mercury arc and carbon lamps in lighting large spaces on all types of vessels. Twenty-five and 40-watt tungsten lamps are widely used for the illumination of staterooms, passageways, and other places where a high illumination is not necessary. The lighting systems have undergone a great deal of improvement, and on large passenger steamers we find concealed lighting, indirect cove lighting, semi-indirect, direct and decorative lighting. Swinging fixtures cannot very well be employed because of the motion of the ship, but similar stationary arrangements give very satisfactory results. Government vessels and battleships are equipped with the most modern installations. Here the engineers have gotten away from the idea that since electricity must be produced for various uses on the ship other than for lighting, the cost for lighting need not be considered. The ruggedness of tungsten lamps as constructed at present has advanced the adoption of this type of lighting. Mazda lamps are used on battleships, where they have been forced to undergo heavy vibration, due to to the firing of broadsides and have been found intact after such severe usage.

A brief description of the lighting of the steamship *Imperator* will serve to give an idea of the lighting of a typical modern vessel. Here an ingenious adaptation of "sky-light" lighting gives one of the rooms actually deep in the bowels of the ship the appearance of an open-deck compartment. The ceiling is divided into 75 panels of diffusing glass, behind which there is mounted a ring-conduit fixture supporting four 40-watt tungsten lamps. These units project a uniform diffused illumination upon the space below, filling the entire apartment with an unusually agreeable quality of light.

At the level of the intermediate deck a visitors' gallery encircles the room behind pillars. Passageways beneath the gallery are lighted by indirect domes set into the low ceiling. For the visitors' balcony, wall bracket fixtures equipped with electric candle-lamps afford sufficient illumination.

Nearly 10,000 incandescent lamps are used for lighting the decks and cabins of the *Imperator.* The turbine-driven generating equipment aggregates 200 kilowatts, in addition to which there is an emergency set driven by an internal-combustion engine, located on the upper deck, which is held in reserve to furnish energy for corridor lighting and wireless signaling in case the main engine-room should be flooded.

The improvement in steamship lighting in the last twenty years has been very great, but there is still a chance for further development, and future lighting should show an advancement comparable with the great strides the electrical industry is taking at the present time.

* Engineering Department, National Lamp Works of General Electric Company, Cleveland, Ohio.

Two Decades of Lighting for Ships and Shipyards

Adequate Illumination of Shipyards Unknown Twenty Years Ago—Improved Lights and Lighting Systems

BY A. R. DENNINGTON*

TWENTY years ago the use of artificial lighting was limited by the lighting units available, so that a condition approaching adequate illumination for industrial establishments was unknown. Shipyards, foundries and similar plants of large area were lighted by arc lamps or by open-flame gas lamps. Local lighting for the individual workman was provided by a bare carbon lamp or by a smoky torch. Very little attempt was made to use shades on incandescent lamps in industrial plants, and in general the intensity of lighting was much less than that which is now considered a usable minimum.

The conditions outlined may be contrasted with those existing to-day. The variety and sizes of lighting units are almost unlimited. The old open-arc lamp has almost disappeared, as it has been displaced by more powerful and more efficient units. To-day the shipyard may be lighted so effectively that work can be carried on at night with as great efficiency as during daylight. The light sources available are flaming arc lamps, Cooper-Hewitt mercury vapor lamps and Mazda lamps. The latter are made in all sizes to meet the requirements imposed by small or large spaces.

In ship lighting the development during the past two decades has been in the gradual change from carbon to Mazda lamps and the increasing use of semi-direct and indirect lighting on passenger steamers. The older method of ship lighting was to stud the ceiling with bare or frosted lamps, and as the ceilings were low the effect was rather glaring. With the use of lamps much brighter than the old carbon came the necessity for the use of diffusing glassware and reflectors to direct the light where it is needed.

Searchlights have been greatly improved and have become much more powerful during recent years and are now an essential part of the equipment of every ship.

The modern ship is hardly complete without a few miniature lamps, which are used as binnacle lights and chart lights and in some cases for producing the low illumination required in the pilot house.

* Westinghouse Lamp Company, New York.

Control of Fire in Marine Properties

Automatic Water Sprinklers Installed for Protection of Marine Properties Afloat and Ashore

BY IRA G. HOAGLAND*

PROGRESS in applying automatic water sprinklers to marine properties afloat and ashore for protection from fires has been made only during the past decade, while in connection with land properties it began thirty-five years ago. Marine properties most extensively protected by sprinklers are wharf sheds and dock storehouses. Quite a few shipyard buildings, mainly woodworking shops, are also thus protected. But as yet only a few vessels—most of them fresh-water passenger craft, particularly Long Island Sound steamers—are fitted with sprinklers. The most extensive sprinkler installations in vessels are in the *Imperator* and *Vaterland* of the Hamburg-American Line.

Fully seventy individual wharf properties in the United States are sprinklered, and many more dock storehouses —there are 110 in the Bush Terminal—in the port of New York. About two-thirds of these wharves are on the Atlantic Coast and the remainder, with the exception of a few in the interior, are on the Pacific Coast. Nearly 60 percent of the number on the Atlantic Coast are in the port of New York. Ports having two or more sprinklered wharves are as follows: New York, 26; Seattle, 8; Boston, 6; Los Angeles, 5; Philadelphia, 3; Norfolk, 2; San Francisco, Cal., 2; Portland, Ore., 2; Tacoma, Wash, 2.

The greatest number of sprinklered wharves in one group are the seven at the Bush Terminal. Since sprinklers were installed, there have been ten fires in these wharves, all successfully controlled by sprinklers, and most of them were nasty blazes in cotton and jute, pregnant with possibilities of disaster like the fire which burned Pier No. 7 in 1904. In 1899 firemen fought a cotton fire in the Bush stores for 38 days. On June 13, 1915, 119 sprinkler heads opened and controlled a fire in 5,280 bales of cotton on Pier No. 1 in ten minutes! Besides the wharf sheds and storehouses there are sprinklered loft factories at the Bush Terminal, and, in all kinds of buildings, there have been 100 fires controlled by sprinklers, and so successfully that $300 (£62) would cover the total property loss.

Nearly 50,000 shore properties are sprinklered. This has effected an economic conservation in life, property and business saved from fire, and in reduction of insurance cost, which, measured by money, amounts to more than $3,000,000,000 (£615,000,000). Of 20,000 fires, 96.4 percent were successfully controlled by sprinklers. In sprinklered properties, fire losses average $250 (£51), and in those that are not, the average is $25,000 (£5,125)!

* Fire Prevention Engineer, New York

An insurance company which underwrites only on sprinklered properties, while increasing its business 7,000 percent, reduced its loss ratio 84 percent! The record of sprinklers ashore speaks for itself, and what has been done ashore can be done at sea when marine engineers realize that it is much more effective to spray water over a fire than to reach it from below by partially sinking a ship. Interest in protecting ships against fire has been stimulated by conferences held in Washington in 1916, under the direction of Secretary of Commerce Redfield, which may have the effect of accelerating progress in using automatic water sprinklers for this purpose.

Progress of Refrigeration in the Marine Field

Rapidly Increasing Use of Refrigeration for Ship's Cargoes and Stores—The Principal Refrigerants and Methods of Insulation

BY H. HARRISON

MECHANICAL refrigeration for marine service owes its start to a need for adequate transportation facilities for meat from countries where the supply very much exceeded the demand to countries where the reverse was true. It owes its growth to the ever-increasing necessity for perishable commodity equilibrium between the several countries; to the universal movement for comfort, sanitation and economy, and to the hearty and able co-operation received from marine engineering in adapting this class of apparatus to the special requirements and conditions obtaining on board ship.

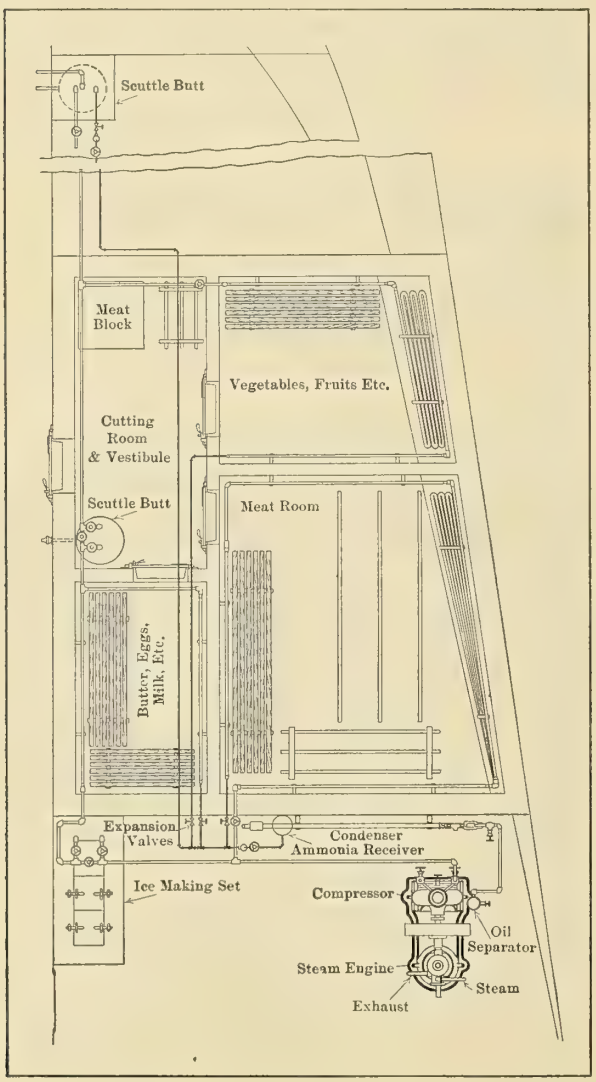


Fig. 1.—Typical Layout of Refrigerating Plant on Board Ship

The progress in the last twenty years is evidenced by the increased number of installations (see Fig. 3), by the increased field of application, by the better appreciation of the investment value of good insulation, by the better understanding (so necessary for a choice) of the chemical and physical properties of the several refrigerants and by the certainty with which the performance of apparatus can now be guaranteed.

Beginning with installations devoted exclusively to cargo storage of meat, we now have marine engineers applying refrigeration to the following:

A. Cargo Storage—
   a. Meats: Chilled (34-38 degrees F.); frozen (12-18 degrees F.).
   b. Fruits (40-45 degrees F.).
   c. General Perishables: Dairy products, eggs, fish.

B. Ship's Service—
   a. Stores: Crew, passenger.
   b. Drinking water cooling.
   c. Ice making.
   d. Air conditioning for staterooms, dining saloons, etc. Temperature about 10 to 15 degrees F. lower than outside, provided outside temperature is over 80 degrees F. Relative humidity about 60 percent.

C. Ammunition magazines on naval vessels (60-70 degrees F.).

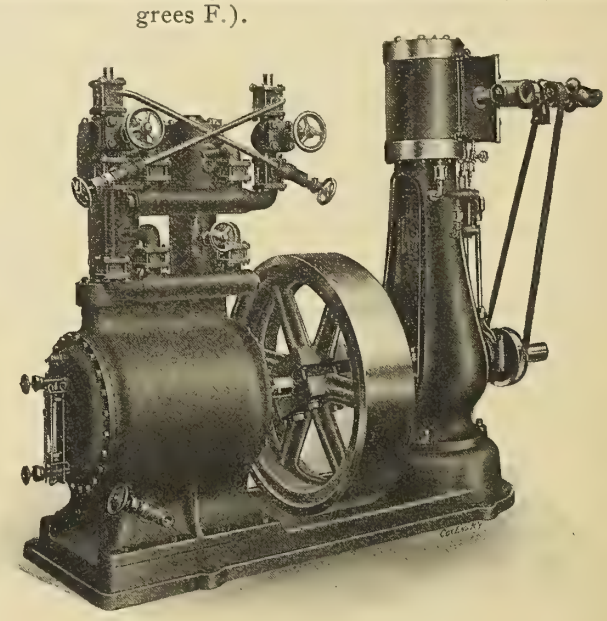


Fig. 2.—Refrigerating Machine, Manufactured by the Brunswick Refrigerating Company

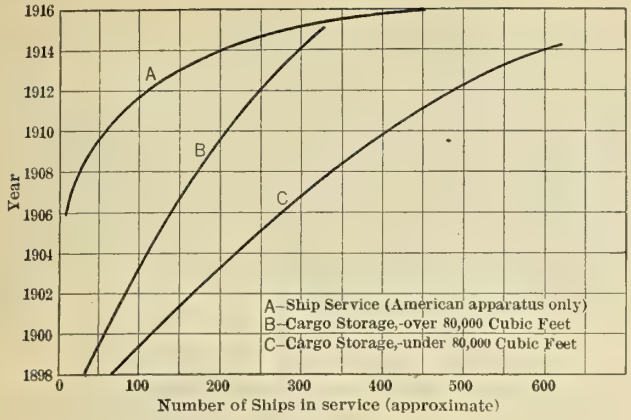


Fig. 3

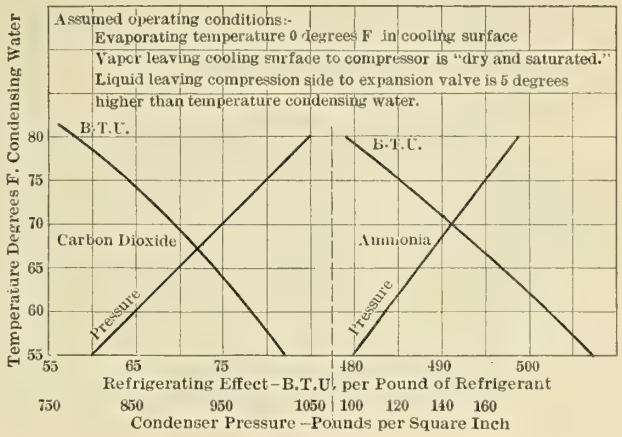


Fig. 4

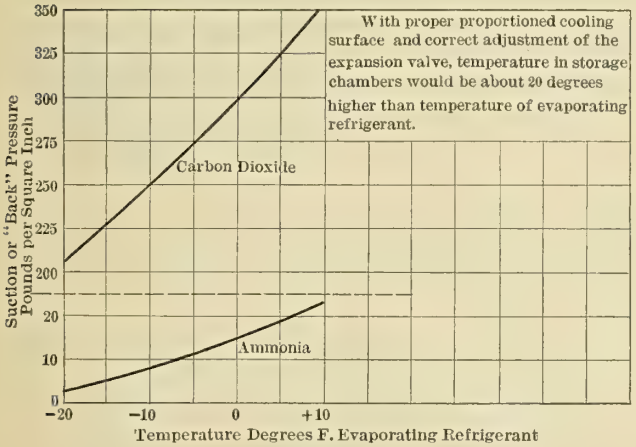


Fig. 5

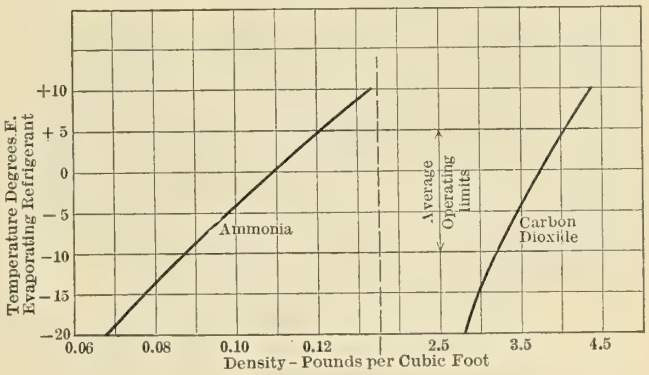


Fig. 6

Refrigeration for ship service has made the greatest progress, both in the matter of number of installations and variety of applications, the development being distinctly American, because the small machines usually required for this service have here received their greatest perfection in reliability, simplicity, economy and comparative low first cost. Fig. 1 shows a typical layout; note the compactness. Fig. 2 shows an American machine; note the evident simplicity.

There are three methods now in use for delivering the cooling effect of the refrigerant—namely, direct expansion, brine circulation and forced air circulation. Marine engineers now realize that no one method can be said to typify best practice; that layout, temperatures required, kind of goods to be stored, and also first cost are the determining factors in the choice. In general, however, direct expansion is the choice for compact layouts in ship service and the smaller cargo storage installations; brine circulation for the larger cargo storage installations and for ship service having scattered layouts; and forced air circulation for cargo storage of fruits and conditioning of air.

Until rather recently powdered charcoal, sawdust, silicate cotton and air spaces, all with board and paper reinforcement, were generally used for the insulation of cold storage chamber walls, ceilings and floors. This class of insulation is being rapidly superseded by pure sheet cork. Pure sheet cork offers per inch thickness maximum resistance to heat flow, and as it is at the same time structurally strong and neither packs nor absorbs moisture, it is an ideal and permanent insulator.

In the past twenty years some half dozen refrigerants have contributed with more or less effectiveness to the progress of marine refrigeration. Of these we still have sulphur dioxide, ethyl-chloride, dense air, carbon dioxide and ammonia. With chemical and physical data now available the selection of the more desirable refrigerants is chiefly based on individual and collective analysis of the following, and since carbon dioxide and ammonia are the leading refrigerants Figs. 3 to 6 are included for ready comparison of their physical properties within average operating limits:

(1) Suction pressure corresponding to an evaporating temperature about 20 degrees lower than temperature desired in storage chambers. If pressure is below atmosphere, special but more or less unsatisfactory construction is necessary to prevent entrance into the system of air and other foreign gases. If pressure is much above atmosphere, special but more or less unsatisfactory construction is necessary to prevent leakage of refrigerant (Fig. 4).

(2) Condenser pressure corresponding to available condensing water temperature. If pressure is too high, expensive construction is required, and even with such leakage of refrigerant is not preventable (Fig. 5).

(3) Latent heat of evaporation at suction pressure. If too small, requires the circulation of excessive weight of refrigerant and, further, with high temperature condensing water the loss in refrigerating effect per pound is very high in proportion to the total heat available, and therefore requiring still further increase in weight of circulating refrigerant (Fig. 5).

(4) Density or weight per cubic foot at suction pres-

sure. If low, requires larger compressor displacement, but in this connection item 3 must be taken into consideration, as this may offset, in greater part at least, any advantage due to density.

(5) Chemical action of refrigerant on such metals as are reasonably available for the construction of the apratus and chemical disintegration of the refrigerant due to continued re-circulation.

Refrigeration is now a highly specialized engineering profession and is becoming more so every year owing to the activities of the American Society of Refrigerating Engineers, the progressiveness of the leading manufacturers of refrigerating machinery and the interest displayed by, and scientific tests performed by, the United States Bureau of Standards. As a result of the foregoing, and what probably indicates more than anything else the remarkable progress in this industry during the last twenty years, is the disappearance of uncertainty and doubt as to the performance of apparatus, positive guarantees now being given as to expected results.

Development of Deck Auxiliaries

Factors Influencing Changes in Design of Ship's Winches, Windlasses and Steering Gear

BY G. E. SMITH *

THE changes in type and design of deck auxiliaries during the past twenty years have been principally along three lines: (1) Greater speed in ship and less lost time in terminals; (2) increased size of vessels; (3) application of electricity.

1. The inclination to increase speed has caused the development of larger and more powerful steering gears for the same size vessels, as well as the design of larger cargo units to handle increased tonnage of the modern steel vessel equipment of to-day.

The desire to reduce terminal delays has fostered the development of special cargo-handling winches and the use of multiple winches at each hatch, in order to handle the cargo in the least possible time. This has resulted in a gradual decrease in the use of the more common double drum winches and the substitution of single drum winches, highly standardized and constructed for rapid and continuous service.

This era of speed has also been felt in windlass requirements for anchor handling. Previous chain speeds, with the older worm-geared windlasses, of approximately three fathoms per minute, have given place, with the more efficient and higher powered spur-geared windlasses (which are to a large extent the recognized standard of the day), to six fathoms per minute.

2. The increased size of vessels has brought about radical changes in point of design, especially of windlasses and steering engines, due to the inability of the owners and builders to concede a proportionate increase in space for the auxiliaries on these larger vessels. This has resulted in the more common use of steel in place of cast iron and the introduction of different types of machines for the same duty, in order to procure units of greater power in equal or less space. This increasing size in the vessels, with its consequent heightened investment, has made materially more important the question of delays, and this in turn has magnified the importance of standardizing parts and machines for interchangeability and quick repairs.

3. The development of the electric machine as exemplified in deck auxiliaries has been somewhat slower than the application of electricity in other fields, both on account of the prevalent use of steam aboard ship and the fact that while deck auxiliaries are usually used for short periods of time only, the maximum load requirement is greater than the normal generator output of the vessel.

The electric winch for cargo handling is comparatively little used. The electric windlass for pleasure boats is in quite extensive use. It is not often employed for commercial vessels, except on fuel oil ships, but in the navy it has practically superseded all other sources of power. Steering engines remain practically all steam-driven, except for naval work, where electricity is now uniformly used.

In addition to the above, occasional applications of the gasoline (petrol) engine have been made, but these have been too infrequent, as yet, to be considered in the nature of a standard development.

At the present time, electro-hydraulic steering gears are being adopted by the United States Navy, and to a limited extent for commercial use, and while the outlook in this direction is encouraging it is too early to prophesy to just what extent this type of gear will be adopted.

Ships' Windlasses

The following is a description of the later types of windlasses now furnished for both merchant and naval vessels by the Hyde Windlass Company, Bath, Me.

The steam windlass illustrated in Fig. 2 is fitted with an auxiliary shaft on which are carried warping heads for quick handling of line. The speed for taking in lines on the auxiliary warping heads is five times as fast as with the warping heads on the ends of the windlass shaft.

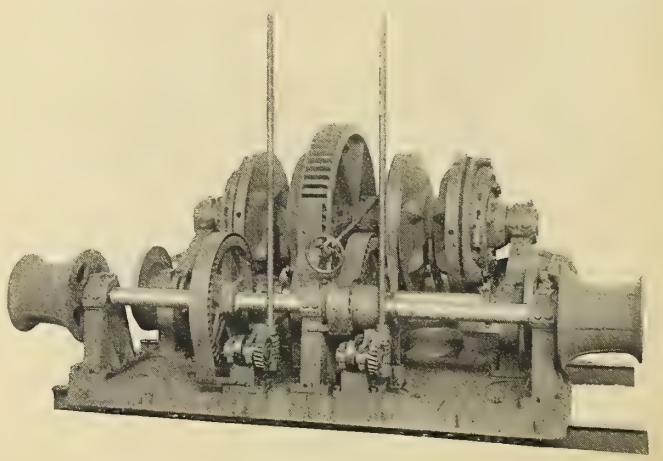


Fig. 1.—Hyde Steam Spur-Geared Windlass

* Chief engineer, American Engineering Company, Philadelphia, Pa.

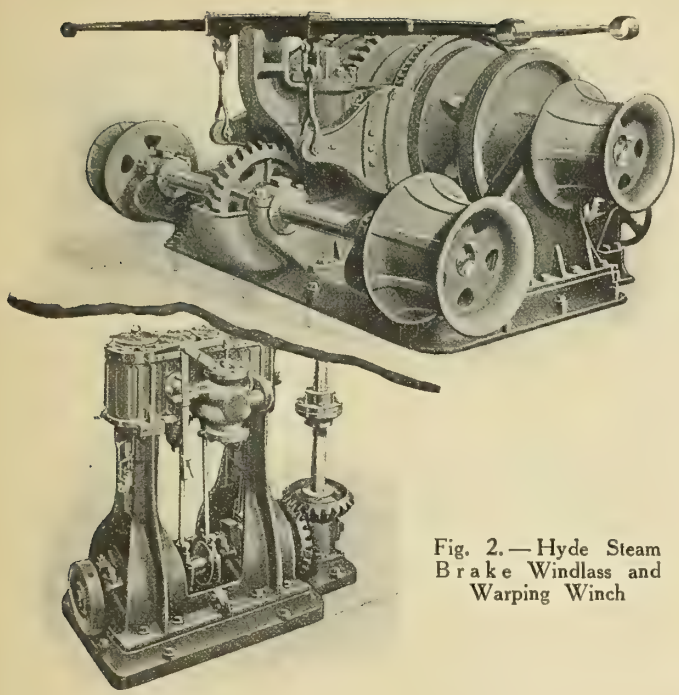


Fig. 2.—Hyde Steam Brake Windlass and Warping Winch

This combination makes a very powerful warping attachment and takes the place of the independent steam capstans usually furnished and located forward on steamships for this purpose.

The steam spur-geared windlass illustrated in Fig. 1 is a type much used. The engine is self-contained on the same bedplate with the windlass. Warping heads are arranged on an intermediate shaft as shown and are used for warping the ship in the same manner as in the worm-geared windlass above described.

The steam vertical windlass illustrated in Fig. 3 is a type of windlass much used on large merchant vessels and also adopted by the United States Navy Department as a standard for all naval vessels. This type makes a very neat and compact arrangement above deck, and the chains have a much more secure hold on the wildcats, where they warp around the wildcats a distance of 180 degrees.

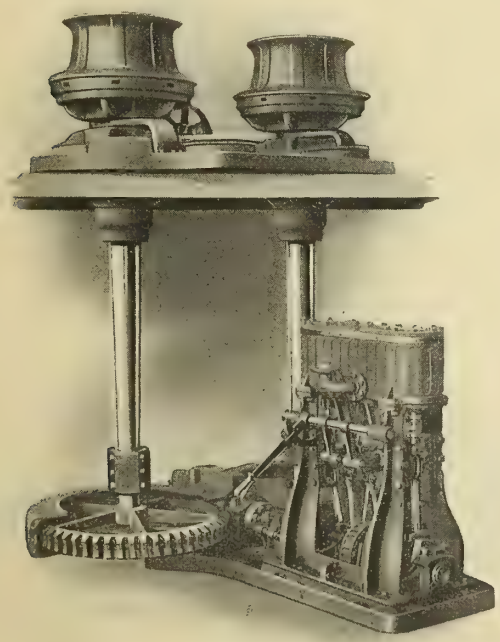


Fig. 3.—Hyde Steam Vertical Windlass

Ships' Winches

While little or no change has been made in the general design of ships' winches during the past twenty years, mechanical changes and improvements, however, have been made. There is to-day a tendency toward using more wire rope than Manila rope in connection with winches. This is because of two reasons, first, the excessive cost of Manila and, second, the speed in handling Manila is dependent upon a man's ability to take it off a

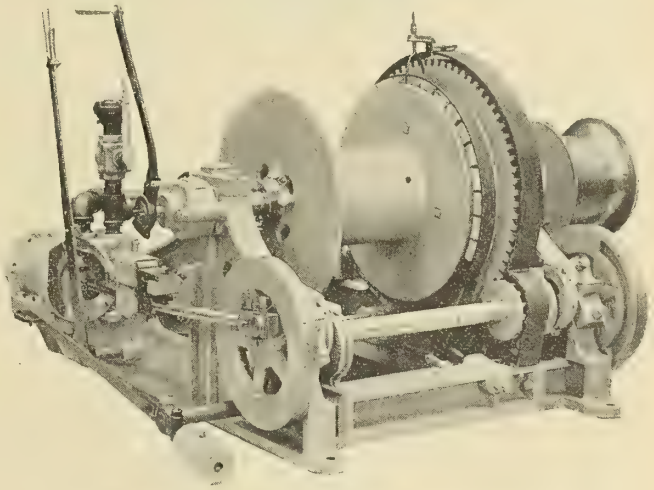


Fig. 1.—Lidgerwood Single-Friction Drum Winch

winch head. With the wearing qualities of wire rope greater and higher speed obtainable by winding it on a drum, this change has caused differences in the deck arrangement of winches, permitting more winches to be used to a hatch.

An excellent example in modern arrangement and type of winches is found on all the new large freighters of A. H. Bull & Company, New York.

These are single-friction drum winches (Fig. 1), manufactured by the Lidgerwood Manufacturing Company, New York. All but two winches on each ship have 8¼ by 10-inch cylinders. Each hatch has two winches. At hatch No. 2 the winches have 9 by 10-inch cylinders and are fitted with reverse link motion. The drums are so arranged that they can be bolted to the gear. This fea-

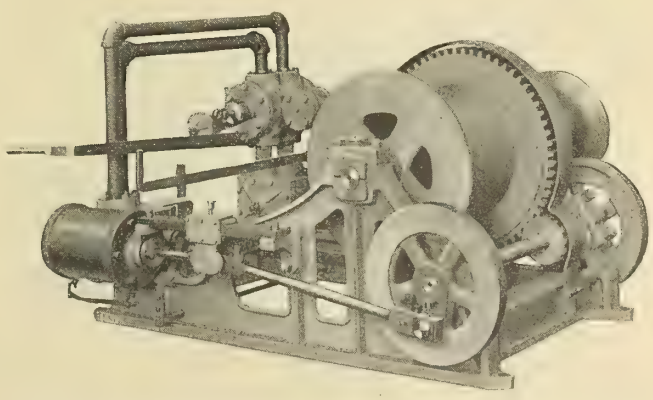


Fig. 2.—Lidgerwood Single-Keyed Drum Steam Reserve-Valve Winch

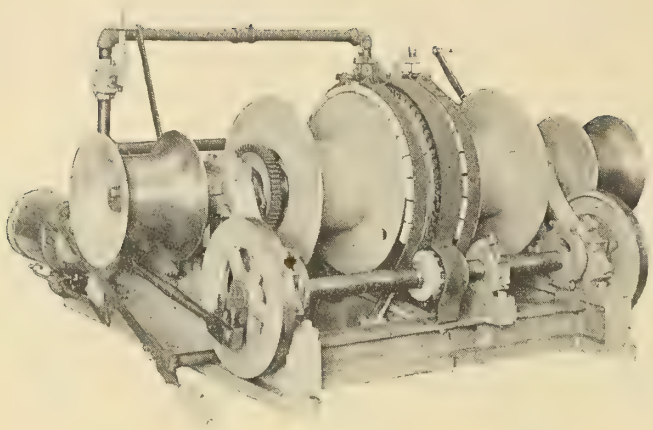


Fig. 3.—Lidgerwood Double-Friction Drum Winch

ture is provided for handling extra heavy loads, at which time the load is lowered by steam.

It is interesting to note that, with this arrangement, discharging can be carried on at both sides of the ship at once. For this two wire rope "whips" and two Manila "burtons" are employed. When discharging from one side only one wire rope whip and burton is used.

Another type of winch, which is fast becoming popular in the lumber trade on the Pacific Coast, is the single-keyed drum steam-reverse-valve winch (Fig. 2), manufactured by the Lidgerwood Manufacturing Company. These winches are aranged in pairs at the hatch and a single operator controls both winches. Wire rope is used on the drums, and the single operator not only controls the hatch whip, but also the burton. These winches are fitted with one winch head, which may be used with Manila rope if desired. The steam reverse valve is of special design and construction, giving perfect control of the load both in hoisting and lowering. There is but one lever for controlling each winch and the operator holds these. The load is lowered by a downward thrust of the lever and is hoisted by an up-pull on the lever.

While it is always preferable to have two single-drum winches at a hatch, on some steamers there is not sufficient deck space. Under these conditions a double-friction drum winch, as shown in Fig. 3, may be used at each hatch. These drums are arranged side by side, with gear between, and in addition there are two winch heads on the outboard ends of the drumshaft. This arrangement provides the same number of drums and winch heads as in the case of the two single-friction-drum winches, but requires two operators.

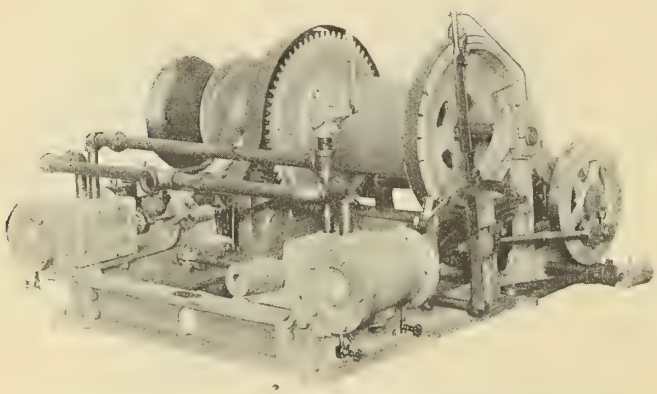


Fig. 4.—Arrangement of two Lidgerwood Single-Drum Reverse-Link-Motion Winches

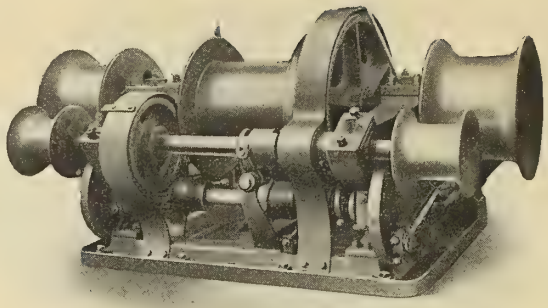


Fig. 5.—Hyde Cargo Hoisting Winch

In cases where a friction-drum winch is not desirable, two single-drum reverse-link-motion winches may be used, as shown in Fig. 4. It is possible for one man to control two winches of this type, while it requires greater effort to throw the links than to operate a steam-reverse valve. For this reason this type is not ordinarily used where one-man control is required.

The cargo winch illustrated in Fig. 5 is manufactured by the Hyde Windlass Company, Bath, Me. It is compound geared, fitted with link reserving gear and friction bands are fitted on drum for lowering heavy loads.

Electrically Operated Ships' Winches

While electrically operated ships' winches are not as yet in extensive use, there is a great deal of interest in the subject, and it is the belief that the day is not far distant when all of a ship's auxiliaries will be electrically operated.

In this connection it may be of interest to note that the steamers *Minnesota* and *Dakota*, of the Great Northern Railway, which were built about 1902, were fitted throughout with electrically driven ships' winches supplied by the Lidgerwood Manufacturing Company. Each of these ships had forty-eight single-drum winches, with which the load is lowered by reversing the motor and controlling the speed by a band brake on the drum.

Steering Gear

The first steam-steering engine built in this country was produced by the Lidgerwood Manufacturing Company, New York, and was of the drum type. A drawing of this steering gear is shown in Fig. 3. The steering engine to-day of this type is only a refinement of the details of the first steering engine built in 1886.

Other types of steering engines have been developed by

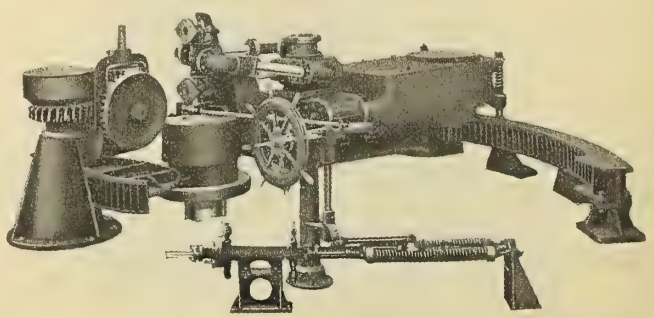


Fig. 1.—Brown Patent Steam Tiller

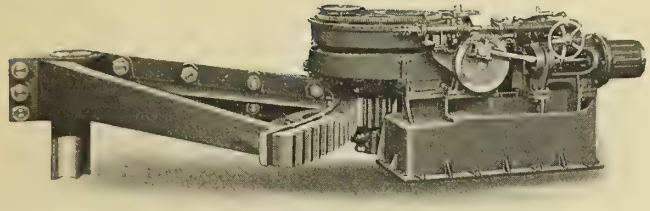


Fig. 2.—Hyde Steam-Steering Engine With Quadrant

the Lidgerwood Manufacturing Company, such as the screw gear, with telemotor and combined hand and steam gear.

The steam tiller illustrated in Fig. 1 is made by the Hyde Windlass Company, Bath, Me. The engine carried on the tiller arm drives a pinion engaged in a rack which is secured to the deck. The worm gear driven from the engine is fitted with an expansion clutch which can be so adjusted as to slip when there is undue strain on the rudder, and this prevents any injury to the rudder or steering gear. The valve of the engine is fitted with a patent automatic check valve so designed that steam is shut off immediately when engine is at rest.

The quadrant type of steering gear illustrated in Fig. 2 is another form of steering gear direct connected to the rudder stock. In this case the quadrant swings and the engine is securely bolted to the deck. The worm wheel of the engine is fitted with an expansion clutch the same as in the steam tiller above described, which slips and prevents injury to the steering gear on the rudder.

A steering gear much used for small vessels, where not

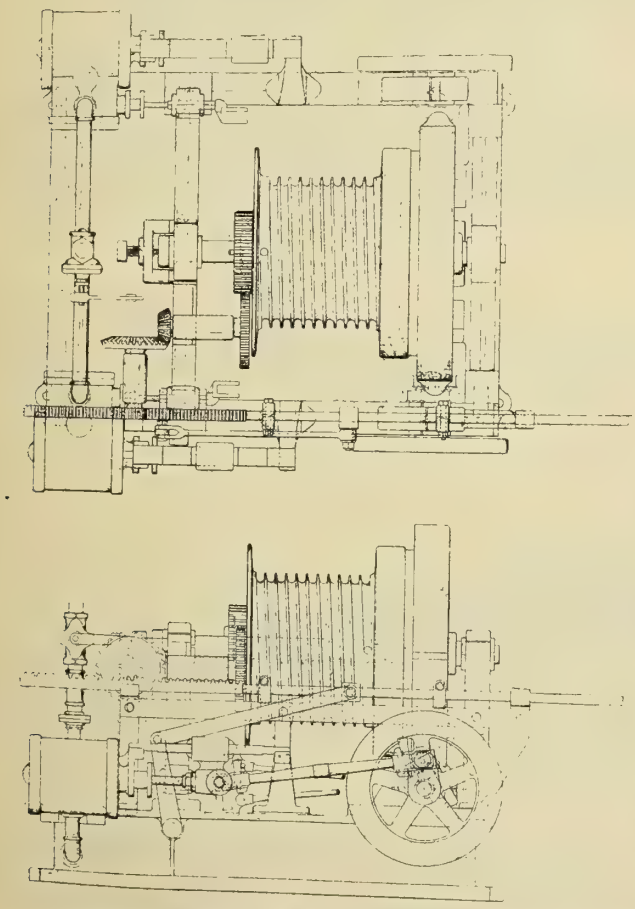


Fig. 3.—Steering Engine, built by the Lidgerwood Manufacturing Company in 1886

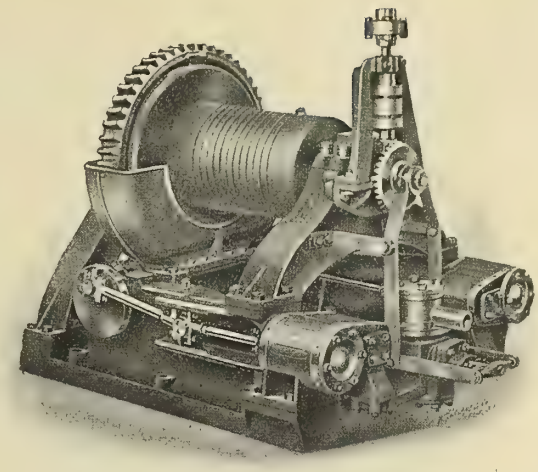


Fig. 4.—Hyde Steam-Steering Gear for Small Vessels

located in close proximity to the rudder stock, is the drum steerer illustrated in Fig. 4. Chains from the drum of this engine lead aft, connecting to the tiller rods or chains.

For a means of transmission between the pilot house and steering engine the hydraulic telemotor is the most approved type.

Marine Salvage Operations

In a paper recently read at a meeting of the Institute of Marine Engineers, in London, Mr. Robert Wright gave a brief description of the various apparatus used and of the different methods followed for salving ships under a variety of circumstances. In the matter of pumps, he stated that those almost universally adopted by salvage engineers were of the direct-driven centrifugal type; they occupied less space and could raise a larger quantity of water in less time and at smaller cost than any other kind of pump. Their principal recommendation from a salvor's point of view was the absence of all valves and contracted passages, which were liable to choke up at the most critical times. The vertical boiler and steam-driven pumps had now been to a large extent abandoned in favor of centrifugal pumps driven by oil engines. The lift of a centrifugal pump, however, was a comparatively limited one, being, under ordinary practical conditions, about 20 feet.

One of the greatest advances with regard to pumps for salvage work, the author pointed out, was undoubtedly the "submersible motor pump." For many years efforts had been made to enclose electric motors with different types of casings, so as to make them watertight and airtight, and the result had always been a failure, as the heat generated set up condensation and destroyed the insulation. The submersible motor made under the Macdonald patents had, however, effected a revolution in this respect, as the windings were insulated by a new process to stand continuous immersion in water.

In concluding his paper the author said it was a matter for regret that England did not have at the present time more and better equipped salvage companies. In his opinion sufficient energy and enterprise in the recovery of sunken and stranded ships had not been displayed, although at no time in the history of the country has there been such a necessity for men with good scientific training and practical experience to apply their talents to this task.

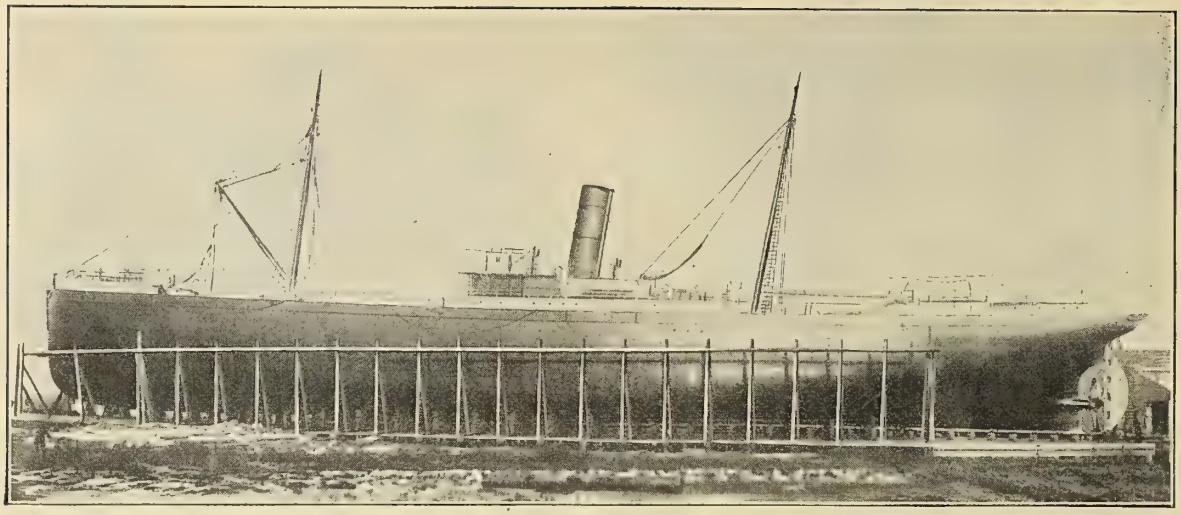


Fig. 1.—Steamship on a "Crandall" Railway Dock

Dry Dock Development in Twenty Years

Features Developed in Basin or Graving Docks, Floating Dry Docks and Marine Railways—Dry Dock Machinery

IT is interesting to note the advance that has been made in the engineering of dry docks during the last twenty years. Then, as now, dry docks in general were mainly confined to the three general types known as the graving or basin dry dock, the floating dry dock and the marine railway. A few other isolated types were in use, but scarcely any new docks of such kinds have been built since then, and some have gone out of use entirely. The general improvements that have been made in the three familiar types above mentioned, exclusive of structural details, are briefly as follows:

Basin or Graving Docks

In this kind of dry dock the general types of construction have remained about the same. Gates and pumping machinery are practically the same except in the matter of size, although the advent of the modern electric motor has greatly improved pumping equipment. The one notable improvement is the fairly general adoption of the bilge block system of supporting vessels.

The main impetus to this improvement was given by the United States Government when in 1892 it adopted the system of equipping battleships with docking keels under the bilges, with the definite purpose of supporting the ships by this means, instead of relying on side shores. The bilge block system had long proved its value in the case of commercial vessels.

The great advance in the matter of size is shown by

Fig. 2.—Warship Docked in Modern Marine Railway Dry Dock

the fact that in 1896 a 600-foot dry dock was considered large, while to-day most new dry docks of this type are being built from 1,000 to 1,200 feet long.

Floating Dry Docks

Twenty years ago the floating dry dock was just coming into its own. At that time there was none of large capacity in America. In 1897 the 10,000-ton all-steel Havana dry dock of Clark & Stanfield's design was considered the last word in floating dry dock construction. This was followed quickly by other large floating docks in the United States and Europe. In 1900 was built the first all-steel dock in America. It was of the Clark & Stanfield type of 18,000 tons capacity, and was built for the United States Government. Previous to that all the floating docks in America were of wooden construction, and wood still remains the favorite material for such docks in this country.

The type of floating dock which at present bids fair to prove the best, at least in America, for docks of large size, is a new adaptation of quite an old idea, composed of a number of base pontoons built of wood connected to continuous steel wing walls.

That the floating dry dock has now fully emerged from its experimental stage is seen by the fact that the British Government has adopted it for its largest war vessels, and has installed at two of its most important naval stations steel floating docks of 32,000 tons capacity. These two dry docks are very complete, being equipped with complete machine shops installed within the watertight side walls. The German Government has gone one step further and has installed a similar floating dock of 40,000 tons capacity at Kiel. There is also one of 35,000 tons capacity located at Hamburg. The largest floating dry dock in America is located at Montreal, Canada. It is of the Clark & Stanfield type, constructed entirely of steel, and has a lifting capacity of 25,000 tons.

Practically all of these floating dry docks are fitted with the bilge block system of support.

Outside of structural details, the main improvements in floating dry docks are comprised in better methods of self docking, reduction of docking time by use of greater and better pumping equipment, and the control of all pumps and gates from central operating stations.

Marine Railways

Twenty years ago the modern marine railway was just beginning to be recognized. The European type, known as the "patent slipway," was a poor substitute for a dry dock, and has not been improved upon since that time, except in structural details.

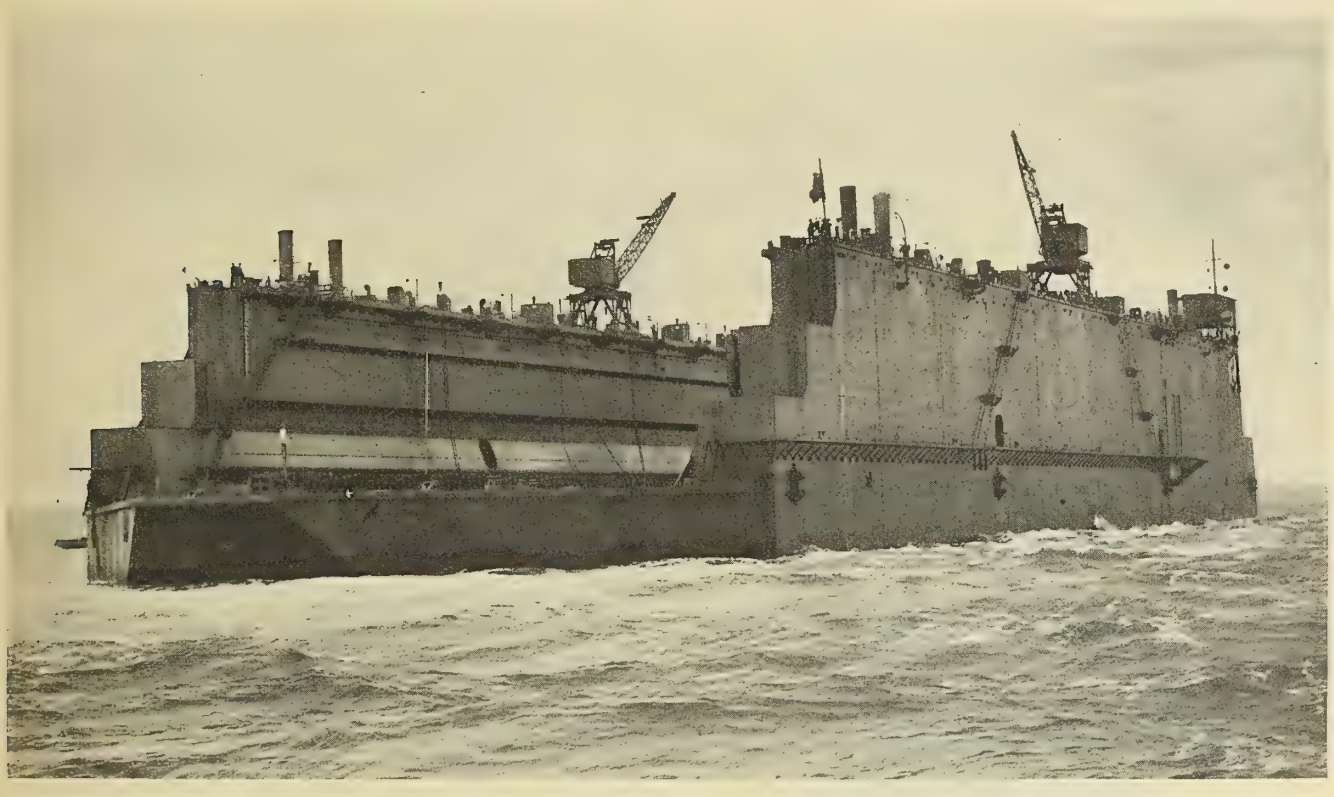


Fig. 3.—32,000-Ton Floating Dry Dock at Portsmouth Dock Yard

The old "marine railway" of America was even more crude than the European type, and little or no engineering experience entered into its construction. Foundations under water were largely a matter of guesswork. These conditions rightly led to the conclusion that the old type of marine railway or "slipway" was unfit to be considered a worthy dry docking means for vessels of any size.

There had, however, been several serious attempts made by one American engineer to produce a thoroughgoing dry dock operated upon the inclined-plane principle, by transforming the "cradle" so as to embody in it all the essential features of a thorough dry dock, and to secure the necessary "lift" by operating this dry dock upon an inclined track. This was the first attempt to produce marine railways upon the basis of good engineering.

This new type of marine railway soon became known as the "Crandall Railway," after the name of its originator. In 1896 there were but three Crandall railways in the United States, ranging from 1,200 to 2,000 tons capacity. There were two in Canada of 2,500 tons capacity, and quite a number of smaller ones. In 1900 a Crandall

railway of 4,000 tons appeared, and since that time a large number have been built, ranging from 3,000 to 5,000 tons capacity.

This development has necessitated the production of greatly improved hauling machinery from the old single chain "horse power" hoist to the modern electric machine operating from four to twelve heavy hauling chains. Upon one of these modern railway dry docks a 5,000-ton vessel is picked up practically as it floats in the water and is hauled up and dry in thirty-five to forty minutes.

Such a work necessitates careful and thorough engineering from the foundation beneath the track to the last detail of the hauling machinery. Thus, while the modern marine railway is but now coming into its own, it represents a great advance in its engineering during the last twenty years.

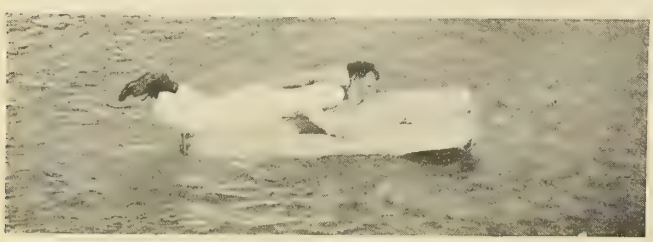
Recent Developments in Life-Saving Equipment

With the considerable improvements in lifeboats and rafts with which vessels are now supplied, additional safeguards in the way of efficient life preservers have been developed in recent years which are of particular interest to passengers and other sea-going people.

It is well known that conditions sometimes occur in cases of disaster at sea where boats and rafts are for various reasons not available. In some instances they cannot be lowered on account of the vessel inclining too much, or they may be damaged. Even when they can be lowered they sometimes capsize after lowering, or become swamped. Passengers and crew entering boats at sea in emergency need efficient life preservers with which they can move about easily so that they will be ready for any accident that may occur in launching the boat or after it is in the water.

Putting on a Universal Ilanasilk Life Preserver

The difficulty of adjusting the ordinary cork life belts and their liability to get out of place, and also their tendency to throw a person on the face in the water is well known. To overcome this, a life preserver has been introduced that is soft, comfortable, easily adjusted, fits adult or child, holds head of wearer out of water even if exhausted or unconscious, and will support the heaviest person for an indefinite length of time. This type, known as the universal Ilanasilk life preserver, has been adopted by the United States Steamboat Inspection Service after thorough tests and extensive demonstrations.



Universal Ilanasilk Mattress and Pillow in Use as Life Preserver

The Ilanasilk filling material has been developed by the Robinson-Roders Company, of Newark, N. J., and is manufactured by that company from the best Java fiber, imported direct to the factory. The Universal type of life preservers has been developed and patented by Lieut. S. P. Edmonds, United States Coast Guard, retired.

The British and Canadian Governments adopted these equipments as soon as their merits were demonstrated. The United States Navy is equipped with life preservers, pillows and mattresses requiring many hundred thousand pounds of this material supplied by the Robinson-Roders Company. Other Government vessels, yachts, motorboats, canoes, etc., are now using such equipments, and a suitable swimming belt is also made for swimmers and those learning to swim.

The pillow is made in the form of a most efficient life preserver as well as a comfortable sleeping pillow, and the mattresses are so constructed that they may be very quickly secured together in the form of rafts. As each berth must be equipped with some kind of pillow and mattress, every passenger has his life preserver pillow and safety mattress at hand. In such disasters as those of the *Titanic, Lusitania* and *Empress of Ireland* such equipments would mean all the difference between drowning and rescue. Their wide adoption for use on Government and other vessels marks a distinct step in advance for life-saving equipment in recent years.

Towing Suggestions—Hawsers and Lines

IN deep-sea work the heavier the line the easier the towing. A decided dip or catenary curve gives the same advantage here as does a long slope of cable with a vessel riding at anchor. The sagging bight acts as an elastic spring, preventing variations in the tension—as from the action of heavy waves striking against the bows of the tow—from being thrown on the line in sudden jerks. The amount of sag depends on both the length and weight of the line.

The dip in no way reduces the line's tension required for steady towing. At the same time it does furnish an

Fleet of Barges in Tow

elastic connection by which the forces arising in the seaway are absorbed gradually.

Manila, on the whole, is undoubtedly the most satisfactory line which can be used, being heavy enough to give a good dip, not too heavy for convenient handling, strong enough and with plenty of buoyancy. Should the manila line prove too light to absorb the shocks of the seaway, a good-sized kedge anchor can sometimes be hung upon it to increase its weight. This deepens the sag and thus gives a larger factor of safety against jerks.

The length of towline needed varies naturally with circumstances. It is far batter, however, to have too much than too little. The use of a margin of safety which seems unreasonably large may result in very comfortable security from vexatious accidents and delays.

It is quite important, when towing in a seaway, to keep the ships as nearly as possible "in step" with the waves. A line should be used of such length that the two ships will meet the waves and ride over them together.

If the length of line puts one vessel in the trough of the sea when the other is on the crest, the line will slacken for a moment and then tauten out with a sudden jerk. If, however, they meet the waves at the same time, the tension on the line will remain comparatively steady.

The wave lengths of a sea are usually approximately uniform at any given time, being dependent partly on the velocity of the wind and partly upon the distance over which this wind has acted in piling them up. For this reason it should not be difficult to arrange the line as above, by either heaving in or veering away the cable on the tow.

Of course, when towing for a long time or over a great distance, extreme variations may be found in wave lengths. The inconvenience of changing the length of towline to meet this condition may more than offset the advantage gained. It is always worth while, however, to start with conditions right, on the assumption that they may continue right.

Correspondence Instruction Among Sea-Faring Men

An Aid for Applicants for Marine Engineers' Licenses— Promotion of Students in the Navy and Merchant Marine

BY CAPTAIN E. K. RODEN *

WHEN the system of instruction by correspondence was first started twenty-five years ago people were somewhat dubious about its character and practical value. At that time educators and men interested in educational matters predicted the attempt to teach by mail would prove a flat failure, and for many years an adverse feeling prevailed against the system. The International Correspondence Schools of Scranton, Pa., founded in 1891, has clearly demonstrated the practicability and success of teaching by correspondence the theory of the trades and the engineering professions, and now after twenty-five years of hard labor has proved beyond question the utility and value of its system, which has become very extended and deservedly popular and has received unqualified endorsements from leading men in all stations of life, trades and professions.

Among all achievements of the I. C. S. in training men for promotion and increased earnings, few surpass in importance the success attained by men that follow the sea. Thousands of men in the deck and engine departments of the navy and the merchant marine have availed themselves of the courses in navigation, marine, electrical, gas and steam engineering offered by the I. C. S., and by actual figures 85 percent of these men have made good.

This speaks well for a system which twenty-five years ago entered its experimental stage. At that time ambitious oilers, watertenders and firemen in the navy and the merchant steamer, who desired to become some day full-fledged marine engineers, had little or nothing to depend upon for assistance other than their practical experience. The brightest of aspirants for an engineer's position progressed very slowly, compared with what may be accomplished by the average man to-day by means of carefully prepared correspondence courses.

Technical education was called for as part of the qualifications of an expectant engineer. So, many otherwise good men were obliged to be content with subordinate positions, or, to say the most, with positions calling only for the lower grades of engineer's licenses, because of lack of education. Conditions have changed since then. Now educational opportunities actually go to those who harbor a desire to become something more than a subordinate, and it creates a desire in those who had no thought of advancing. The I. C. S. system is solely responsible for this changed condition of affairs. It appeals to the man at the foot of the ladder to climb and do better.

There is no excuse now for an ambitious man in the engineers' department of any steam vessel to remain in a subordinate position any longer than the law calls for. He can study "off watch" while putting in the required sea service, and at the end of that service he will be prepared to pass his license examination. Incidentally, it may be stated that I. C. S. courses are infinitely more than a mere preparation for examination. They teach the elements and underlying principles of the profession and show how to apply them. Preparation for an examination does not do that. A candidate wants more than a license; he wants the real knowledge that the license is presumed to represent. During its career of twenty-five years the records of the I. C. S. show that until October 1, 1916, it had enrolled 11,427 students in the navy and 16,103 students in all classes of merchant vessels. Included in these figures are men who now serve as engineers, captains and deck officers, but who previous to taking up courses served before the mast. That I. C. S. courses have proved a benefit to enlisted men in the navy is shown by the fact that of the 42 warrant officers who up to this time have been appointed to the rank of commissioned officers, 33 were I. C. S. students.

Studying by correspondence is no lazy man's job; it requires grit, perseverance and a firm desire to get ahead. But to those who really want to dig in and do their share in helping themselves, there is an avenue open through correspondence instruction by which to reach their goal.

* Technical manager Army and Navy Department, International Correspondence Schools, Scranton, Pa.

THE TERMINAL SHED AND WAREHOUSE

Municipal Piers at Port of Seattle, Wash.

Fig. 1.—Terminal Sheds at Seattle, Wash., Showing Dray Road and Car Placement Tracks

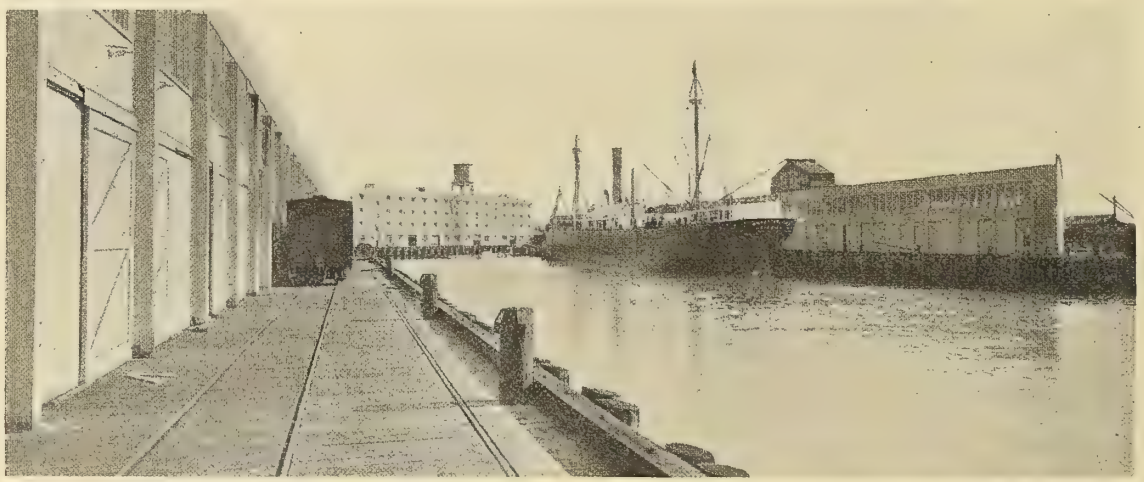


Fig. 2.—Car Track and Crane Rail Between Shed and Edge of Pier at Seattle Piers

Fig. 3.—Reinforced Concrete, Four-Story Terminal Warehouse at Seattle

Fig. 4.—Pier Sheds, Marginal Way and Car Placement Tracks at Seattle Terminal

The Terminal Shed and Warehouse

Comprehensive Discussion of Pier Shed and Terminal Warehouse Design—Shed and Warehouse Capacity—Details of Construction

BY H. MC L. HARDING *

IN terminal engineering there are certain rules and principles which in general can be adopted and adapted to new work with advantage. Like all similar engineering rules, and especially in the marine field, they represent the standard practice of the best terminals, at the ports with the best facilities.

A careful study of many marine terminals, chiefly abroad, shows not only a similarity in design, but a tendency and positive trend to follow such plans in all new work.

Example of Standard Practice

To illustrate and give one example, the general practice on the Continent in Europe has been to set the sheds back some thirty-five or forty feet from the edge of the quay and pier, with railway tracks between. These railway tracks should be set flush with the pavement, to permit of the use of this intervening space by auto trucks, which have become an important element in port development. This space is spanned by gantry cranes.

The practice at Liverpool and in the United States was to have the shed walls within about six feet of the edge. This is even now recommended in some civil engineering handbooks published in the United States.

Change at Liverpool

In July, 1914, the chairman of the Mersey Harbor Board (Liverpool), as per the United States Consular Reports, stated that as the practice of setting back the sheds was much in vogue on the Continent, being the almost universal custom, although it was a considerable departure for Liverpool, they would adopt it for the new quays and piers about to be constructed.

Latest American Practice

Since then the same plan has been adopted in the United States at Seattle in the latest developments (see latest views and reports); at Montreal, from the last report of Hon. W. G. Ross, President, Harbor Commissioners; at New Orleans, piles are being driven outside of the present quay, and railway tracks are there being laid; and at the new pier of the City of New York, recently leased by the Luckenbach Steamship Company in Brooklyn, in which case the lessee, against great opposition, insisted upon and secured the same innovation; at Beaumont, Tex., Galveston and elsewhere the same rule is being followed.

The above is only cited as one example of many, as indicating how the practice of the most successful ports which have had the largest mercantile marine has become a rule of terminal engineering.

By the adoption of this design greater speed and economy are attained, and the elimination of the dock or ship winch congestion.

Even more striking illustrations could be given from the design of substructures of quays and piers, of the co-

* Designing Terminal Engineer, New York, N. Y.

THE TERMINAL SHED AND WAREHOUSE

Construction of New Marine Terminal at Beaumont, Tex.

Fig. 5.—Vessel Moored at New Beaumont Terminal

Fig. 6.—Erecting the Shed, Showing Type of Construction

Fig. 7.—Top of Quay Wall

Fig. 8. Rear of Quay Wall, Showing Area to be Filled with Sand Pumped from the River

Fig. 9.—Face of Concrete Quay Wall Protected by Oak Fenders

ordination between cars and vessels, in the plan design and material of the superstructures, and still more forcibly in the adoption of mechanical appliances to freight handling instead of depending upon manual labor.

This present paper will refer chiefly to terminal sheds and warehouses.

Distinction Between Sheds and Warehouses

Their design, arrangement, dimensions, location in reference to each other and the whole terminal and costs are herein briefly described. It is hoped that the results of the study of many terminals may be of service to others, who are not hampered by tradition, and who, as terminal engineers, are designing similar terminals.

The following is not intended to be a specification or a complete and final description, but to indicate certain terminal principles pertaining to terminal shed and warehouse problems.

The Shed

The terminal shed differs from the terminal warehouse in its functions, in its design and construction.

Speed Capacity

In the shed, the feature most desired is speed of operation, whereby there will be avoided interference with freight or cargo movements, and the elimination of all possible points of congestion.

The ship must be discharged and loaded with the greatest rapidity, as its charter value may be a thousand dollars or even more per day.

Berthing Frontage

The most valuable portion of a terminal is its linear berthing frontage. This frontage may be said to be the controlling factor as to the capacity of the terminal. If a terminal should cost $1,000,000 (£205,000), and by means of design and facilities twice the number of ships can be discharged and loaded in a given time, then the investment of $1,000,000 (£205,000) would be the equivalent of an investment of $2,000,000 (£410,000) with a frontage not so designed and equipped. For miscellaneous or package freight the shed often is the place of congestion.

As the inbound cargo is generally of many marks, which must be assorted, distributed and tiered according to these marks within the shed, the necessity of free and quick movements is evident, as well as the avoidance of anything which may cause delay in obtaining the essential speed-capacity. Economy follows speed.

No Intermediate Columns

The terminal shed should be free from intermediate supporting columns, which, besides wasting much floor space, obstruct the movements of distribution, causing the loops of freight travel to be greatly extended.

If a pier be very wide, it is preferable to have two sheds upon it with tracks between, besides the tracks between the shed and the edge of the pier.

The shed should be well lighted from outside, and for the high tiering about double the height of the usual type of marine shed.

One High Story of More Capacity Than Two of Usual Height

By thus increasing the clear vertical space below the girders to thirty feet, the shed, though of one story, will have more capacity than that of two stories, each of the usual height of fifteen to eighteen feet.

When the shed is of two stories, to store freight on the second story would require the installation of the interfering columns in the lower story to support this weight.

There would also be the loss of holding space which would be occupied by the second-story floor and girders. The number of foremen and inspectors would be doubled for two floors.

The upper story for inbound cargoes and the lower story for outbound cargoes, or vice versa, has not been successful.

With the high one-story shed there is better daylight, and hence less thefts and idleness.

Five hundred-candlepower tungsten lamps are suitable for night lighting.

High Tiering

Instead of the usual five feet tiering of the cargoes, twenty feet tiering by mechanical appliances is the rule—that is, while on two stories there are only five feet plus five feet, or ten feet, with a high one-storied shed tiering twenty feet twice as much cargo can be placed within the shed.

A two-story shed also may cost on the average twice that for the one-story shed. This is especially true taking into consideration the increased cost of the wall foundations which are near the water's edge.

The Shed Function—Temporary Holding

The function of the shed is only for temporary holdings, not long storage. After forty-eight or seventy-two hours' holding, the cargo must be removed to provide room for other cargoes from or to other ships.

The floor should be clear for the new freight.

Continual Operation

There are continual movements in loops of freight in, or cargoes out, all day and often nights and Sundays.

This freight handling is often continuous without cessation, and is only surpassed in uninterrupted operation by railway transfer stations.

Shed Holding Capacity

Larger and broader ships are now being constructed, therefore there should be a corresponding larger shed holding capacity.

The custom has been to make the shed about one hundred feet less than the longest ship expected there to berth, or one hundred feet less than the berthing frontage, and with a capacity equal to the cargoes of two such ships, or for one inbound and one outbound cargo.

The next ship along the quay would have its shed, there being as many sheds as ships or berths.

To hold such a cargo of miscellaneous freight piling to the usual height of five feet would require a very broad shed; it is therefore necessary to tier to a greater height.

If the ship's length and berth be 600 feet of linear frontage, then the shed should be 500 feet in length and 80 feet wide. If the berth be 500 feet in length, then the shed should be 400 feet long and 60 feet or 80 feet wide. The sheds should be extended along the quay or pier with ample fire space between the ends of the sheds.

Assuming that two cargoes would equal 12,000 tons, then for package freight at 60 cubic feet per ton and allowing for the aisles and working space sufficient to bring the space per ton equal to 65 feet, then the cubical content would be $12{,}000 \times 65 = 780{,}000$ cubic feet.

A shed 500 feet by 80 feet by 20 feet (30 feet high) would have a holding capacity of 800,000 cubic feet, about 10 feet being allowed above the tiered cargo.

If piled only 5 feet high, the economical height for manual labor, the dimensions of the shed would be 500 feet by 320 feet by 15 feet, thus requiring an excessively large floor area and a shed cost of over three times as much

nd operating costs of three or four times as much, due to the greater distance of freight conveying and the necessity for more manual labor and less mechanical movements. The cubical space per ton varies according to the nature of the cargo.

Congestion May Double Time and Cost of Handling

A block of the freight movement or congestion at any one point may double the time and cost of handling. Congestion often causes rehandling, breakage and long delays.

Speed Capacity

Speed, speed-capacity, is the most important condition to be attained within the shed walls, as well as at the whole terminal, and this fact must always be uppermost in the terminal engineer's mind.

Shed Location

On a quay or pier the shed should be set back from the water frontage, and parallel thereto from 35 to 45 feet, with two or three railway tracks in front and also at the rear of the shed; the front tracks chiefly for outbound cargoes and the rear tracks for inbound freight.

Gantry Cranes Outside

These tracks with cars should be spanned by specially constructed gantry cranes of light weight of two tons capacity and low first cost. The number should be one for each 100 feet linear frontage. Every fifth crane may be of five tons capacity.

Shed Material

The sheds should be of steel, not concrete; fireproof, 60 feet to 80 feet wide, and equipped within with cross traveling cranes with adjustable loops for the mechanical quick assorting, easy distributing and high tiering.

Any little settling of the shed columns can be easily remedied by shimming, which would not be easily done if the building and the columns are of concrete construction.

It is often desirable to add other appliances or supports in the shed or to make changes. This is difficult when the building is of concrete.

Details of Construction

The sides and ends of the shed should be of galvanized corrugated metal, to be carefully painted inside and out, or asbestos covered.

The ends of the sheds may be of pleasing architectural appearance. A flagstaff, roof scuttles and ladders should be provided.

While the roof of the shed may be of different kinds of material, tar and gravel roofs are satisfactory.

The floor of the shed is of concrete 6 inches in thickness, in 12-foot squares for expansion, and surfaced with 1½ to 2 inches of asphalt.

The toilet rooms should preferably be within the sheds and at the ends, for easy supervision by the foremen. The walls of the toilet rooms should be coated to the height of seven feet with asphaltic or bitumen paint to prevent rusting, so that they can be easily cleaned with the hose.

There should be small rooms at the ends of the shed by the side of the end doors for the door keepers and receiving and checking clerks.

The water main may be on the side or center of the shed if overhead, and of sufficient size for the sprinkler system. Meters within and fire hydrants just outside the sheds should be installed.

For a terminal of several sheds and warehouses, there should be a separate office building for administration, engineering and drafting, and not have such offices occupying valuable shed space. The warehouse also should not be open to all who must have access to the offices, therefore the general offices should preferably not be in the warehouse.

The shed may be stated to be a place designed for the quickest freight handling, chiefly inbound, and for short temporary holding, but not for long storage.

The shed is open to draymen, shippers, consignees, their clerks and messengers and many others, and is the scene of the greatest and most feverish activity.

The Warehouse

With the warehouse all is different; where the shed is full of noise and speed, the warehouse is quiet and deliberate.

By means of machinery the merchandise, after about seventy-two hours, is swung by cranes from the floor of the shed to any of the floors of the warehouse, where it may remain for a month or a year, or as long as the storage charges are paid. Speed of movement is not so essential, and all the functions are different from those of the shed.

There must be full protection against fire, theft, or any possible injury to the contents, and no one can enter the warehouse without a permit.

Warehouse Construction and Design

The warehouse, instead of being of steel, is of thick, reinforced concrete with wire glass windows. While it is of the same length as the quay shed and parallel to it, with a width of 80 feet, if the location permits, the number of stories and the internal arrangements vary, often depending upon the nature of the principal commodity to be long stored.

All steel sheds, except in respect to length, are much alike. In the warehouse this is not so, as there might be one arrangement for cotton, similar to Manchester, England, another for general merchandise, as at Bremen or Mannheim, another for perishable goods which require cold storage, and others where an equable temperature is necessary, as at Seattle, Wash.

The points of similarity, though not fixed, are the width and length. For general merchandise the number of stories would be either four or six, six stories giving the greatest number of cubic feet for the least investment. Material, as stated, should be reinforced concrete.

The building should be constructed on most firm foundations, as any settling would be of great detriment to the appearance by causing unsightly cracks.

Shed Costs

The cost of steel sheds during the past three years has so greatly increased that any figures made previously would have but little value at the present time. On account of the almost daily variations in the price of materials, transportation and labor, there must necessarily be wide margins in general estimates. It would, however, be safe to average the cost of high steel sheds between 3½ and 4¼ cents per cubic foot, outside measurements. To this should be added the price of the machinery and plumbing and other appliances.

There will be no partitions, only one large open space., and being of simple construction, will be of proportionately low cost. The dimensions of each shed would be: For large ocean terminals, 500 feet long, 80 feet wide and 30 feet to 35 feet clear height below the girders, with one span; for inland ocean terminals, the dimensions may be 400 feet by 60 feet by 30 feet, and for inland river barge terminals, 300 feet by 60 feet by 30 feet.

(To be concluded.)

Marine Machine Shop Equipment

Tools Ranging from the Smallest and Finest to the Largest and Heaviest Required in Shipyard Machine Shops

BY W. D. FORBES

FROM stem to rudder, from keel to mast head and from bulwark to bulwark is a space which has to be filled with a multiplicity of articles which in numbers and variety cannot be found save in a ship. From the delicate setting of a chronometer jewel to the ponderous, bulky, rough anchor there is an immense range of work requiring machine tools.

Of course, all articles aboard ship are not produced in a shipbuilding establishment. The shipyard does not make chronometers, and rarely, if ever, anchors. The work has to be differentiated, yet in a shipyard there must be tools which remove material ranging from the fine dust from an emery wheel to the huge chips which are stripped from the heaviest forgings.

Routing of Work

We have heard a great deal about what is known as the "routing" of work, which merely means that care must be taken to start the rough material as one end of the shop, machining it as it advances, until it leaves the other end of the establishment, without retracing its steps, a finished product ready to erect or place in position. In ship work this becomes a matter of prime importance, as a large percentage of the machinery built is very heavy and its transportation from machine tool to machine tool is an expense which must be seriously considered.

This transportation demands cranes and these have been brought to a marvelous state of perfection by the introduction of electric drive.

This idea of "routing" is a little complex to consider in shipbuilding, as there must be some retracing unless conditions are very peculiar. An ideal condition would be: A shipyard built on a peninsular, where on one side raw material is floated to the dock, started on its path of manufacture and delivered on the other side of the peninsular to the hulls on their ways. This would mean, of course, that the shops would lie parallel in their greatest length with the ways. In many cases shipyards have just grown and not been planned. Buildings have been added as necessity required and time and capital permitted. A shipbuilding plant which the writer has in mind was carefully planned, and in building, the original design followed did not adopt this idea but placed its main machine shop at right angles to the shipways, with the result that material has to be transported further than seems justified.

Laying Out the Work

Let us consider the production of the heavier machinery which goes aboard ship, disregarding entirely the hulls. First, all parts of machinery have to be laid out. It is customary, though in the writer's opinion a mistake, to allow the machine-tool hand to do much of this laying out, if not all of it, with the result that his machine tool is not making chips to its full extent. In order to lay out there must be provided some accurate plane surface from which to start. Such a plane surface should be of finished cast iron, set perfectly level and, of course, served by overhead cranes.

When the work is laid out it proceeds to the machine tool to be placed on centers or bolted to platens. The large machine tools required are not merely the enlargement of the ordinary lathe, planer or drill press, but they are quite often provided with means of doing work which does not usually belong to their particular class of tool. For instance, a large planer may have one of its heads fitted with a slotting attachment and quite often means by which drilling operations can be carried out. These features are valuable, as by them in many cases alinements are more accurately and quickly made than if the mass is removed and set up again.

It must be admitted, however, that a careful consideration of many of these larger machine tools has shown me that these special features have not been as carefully considered as they should have been. In one case a very large planer was fitted with a slotting head, the design of which was so weak that it simply nibbled off the material instead of taking a perfect cut. This lightness demanded great skill on the part of the machine hand in order to get true surfaces, and operations took an excessive amount of time. The same condition existed in the drilling attachment.

Such large tools, of course, are not carried in stock, as their cost runs into thousands of dollars. They are therefore ordered and quite frequently certain special features are demanded which must be made in a prescribed way which considerably hampers the machine tool builder. How far these special features should be carried is a serious question, yet it is merely a matter of some figuring to see whether they are advisable. Suppose we have a planer costing $30,000 (£6,150). It is primarily for producing plane surfaces, but if on the class of work to be done there is considerable slotting or drilling, the question is simply whether the slotting and drilling should be done in a tool of this price or whether the work should be removed to a tool of very much less cost and there carried out, thereby relieving the higher-priced tool of interest charges and increasing its production of legitimate work.

Surfacing

Broadly speaking, whether the reciprocating or turbine engine is to be produced the first work is that of surfacing, and from such surfaces all other work must be laid out. There is much work which is now being done on a planer (a reciprocating machine) which of late years has been done by a continuous rotary cutter with inserted teeth of high-speed steel. Such tools, it seems to the writer, have not come into their own and there is a field open to the machine tool builder who will give his attention and study to improving this class of tool.

Among men who have spent years in the shop can be found a prejudice against this class of tool, and this is so for two reasons. One is well founded, and that is that the builders of tools have not put as much material in the tools as they should, nor have they put it in the right place, with the result that some of the work has not come out as true as it should, and for the erectors to attempt to correct inaccurate machine work is a heartbreaking job, besides being an expensive and unsatisfactory condition. The second objection comes merely from the scratchy appearance of the finished surface. Although this should have no weight, nevertheless it does.

The large lathes for marine work are too well known to require any special description and are pretty well refined, but it should be remembered that the high-speed steels of to-day admit of a greater number of revolutions and remove more material at one cut than formerly. It therefore follows that far greater rigidity and greater strength in the drive are required. These large lathes are also specially built and are not by any means stock articles.

As changes occur in the design of machinery special tools for such new designs must be considered; for instance, boring large cylinders for the reciprocating type of engine permits of a vertical tool being used and work of great perfection can be confidently looked for and is obtained from these. Sometimes the tools used are of the revolving table type of vertical boring mills. Here again slotting and drilling attachments are sometimes provided, but often the boring is done on a stationary table by means of a revolving vertical boring bar. This machine has the advantage of simplicity in boring proper, but is practically useless for any other operation save for a certain amount of facing, while the rotating table style of boring mill is available for a much larger range of work. In smaller sizes this type of machine tool has been most marvelously refined during the past few years, but the writer has been unable to see anywhere near a corresponding advance in its larger brother.

Boring Operations

To-day the steam turbine demands boring operations which require a far greater nicety than the earlier builders of this prime mover supposed. There are, no doubt, some who build tools for this work whose designs are unknown to me, but those I have seen were usually makeshift affairs which, while extremely ingenious, did not do the work with anything like the celerity or exactness which the importance of such work demands, either from the mechanical or commercial side. Nor have I seen any design for as rapid drilling of casing bolt holes as should be on the market.

The writer is rather a crank on the drilling of large holes and has found by many practical experiences that a pilot drill makes for great increase in speed of drilling. I do not mean by this, as one of my friends understood, that a 3-inch drill with a ½-inch drill fitted to its center and driven at the proper speed for a 3-inch diameter of drill will help matters, but that the ½-inch drill should be first used at its proper speed and then followed by the larger drill.

All large tools for ship work should, of course, have independent drive, as their great cost demands that they should be twenty-four a day workers as near as possible.

Grinding

The grinding operations, which not long ago were looked upon very largely as somewhat super-refined and very expensive, have proved themselves neither, but quite necessary and thoroughly economical. Certain classes of work, which years ago were filed to a finish and out of all concentricity with great labor and pride, are now quickly and accurately done by the grinder, and the end is not yet. We all dearly love a handsome finish and it has a commercial value in keeping up the pride, resulting in better attention of those in charge.

The tools previously referred to are used for the major pieces of ship machinery, but it will astonish many to see how gradually the size of machine tools required tapers down until we reach the small precision bench lathe with its accurate drawing-in chucks. These small tools are quite commonly looked upon as an unnecessary refinement in marine machine shops, yet they are an extremely economical machine tool. The system of drawing-in chucks, which originated with them, is now being extended to quite a large diameter, large enough, I understand, to take in 6 inches, although I have never seen anything as large as this. There is no reason, however, why the system should not be extended to any length.

The regular standard lathe can never be entirely replaced on account of its great range of work and simplicity of tool, yet the market has been furnished with tools of a class which will produce duplicate pieces accurately and quickly without the necessity of the expensive box and other special tools used heretofore on screw machines. In skilled hands this class of tool is coming more and more into use, even in jobbing shops. We usually connect screw machines with bar work, but the machines which I have in mind and have referred to will not only handle bars but, within certain limits, castings.

Portable Tools

There has been a class of tool introduced which has been made immensely valuable by the electric drive. These are of the portable class and can be most advantageously employed in doing work on large pieces of marine machinery, either before or after they are set in the hull.

A tool which I have often wondered has never been produced for large machine work is what may be described as a multi-spindle-independent-radial-frame drill. This is a pretty long hyphenated word, but its general idea would be this: a large platen capable of a movement after the style of a planer bed, over which would be built a girder which could be raised and lowered. To this girder would be swung four radial drills, independently driven. These drills could be moved across the girder so as to bring them into any position required, the piece to be machined, of course, resting on the platen. These drill spindles should be made stocky enough to carry a good-sized inserted tooth-milling cutter and on the verticals which support the girder other drills of the same class should be set for right angle work. Of course, each spindle would require a man to operate it, but there is a good deal of work which could be handled by such a tool.

It is not easy for machinery men unfamiliar with ship building really to understand what a large field there is now looming up for machine tools for shipyard use, and I have been rather surprised to find men connected with the machine tool building industry who have the idea that all ship work is rough and what the Scotchman called "one-eight part" was about as close a measurement as marine work requires. This is, of course, a great mistake.

The Machine Shop on Board Ship

All well equipped ships to-day carry on them quite a machine shop, consisting of at least a drill press, shaper and lathe. These tools are now electrically driven, which make them far more serviceable and convenient than heretofore. Here again is a large field for improvement in tools especially adapted for this use. Repairs at sea have but one idea in view—that is to make them as soon as possible. Cost for the actual job has no significance, therefore makeshifts and nibbling processes are perfectly admissible and unavoidable.

Many modifications could be made in the machine tools for ship use which would widen their range, thereby increasing their value; and with the outlook in shipbuilding to-day special designs for machine tools to go afloat are well worthy of the consideration of designers and machine tool builders.

Returning to the machine shop, the gallery design is

very common. Under these and on them are placed the smaller machine tools of the plant. If under, then some means for easily moving and lifting material should be provided which would demand separate and smaller overhead cranes, as the work on the lower floor is usually quite heavy.

The tools that are placed on the gallery do such work as can be easily lifted in by two men. To my mind such an arrangement has serious objections and I would much prefer that the lighter machine tools should occupy separate buildings, which I would place at right angles and leading into the main shops. I have heard objections to this idea, the main argument being that the men who have often to fit the small work to larger pieces would be obliged to walk a considerable distance; but this argument I do not think holds, as a man would have to walk equally far to reach the stairway from the gallery, descend it, walk to the place where the fit must be made and then retrace his steps.

In the smaller tools the question of their drive is interesting, and my experience goes to show that grouping the machines and driving the group with independent motors is more satisfactory and economical than individual drives for small tools. It is quite possible that with the change in steam prime movers and internal combustion engines very radical modifications will have to be made in marine machine shop equipment, more so as the first of the prime movers gains in popularity, and undoubtedly the latter type will call for designs much modified from what can now be found in the machine tool market.

Two Decades of Pipe Threading

BY H. S. ASHMUN*

THE oldest known stock and die for threading pipe (Fig. 1) is a stock with hand-forged, solid handles. The dies, which are an integral part of the stock, are made from slices of round tool steel. The tool probably dates back to about 1850. About fifty years ago the square pipe die (Fig. 3) commenced to gain in favor, and as recently as twenty-five years ago it was almost universally used in power machines as well as hand tools.

Fig. 1.—Oldest Known Stock and Die

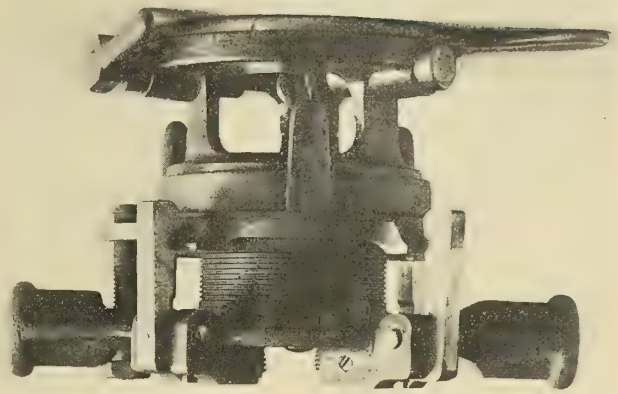


Fig. 5.—Modern Threading Tool, Embodying the Receding Principle

Not losing sight of the natural advancement which, in time, men bring to bear on all industries, we must not forget that in the threading of pipe the big forward step was caused by the introduction of steel pipe. Two decades ago the adjustable, or two-piece, die was coming into

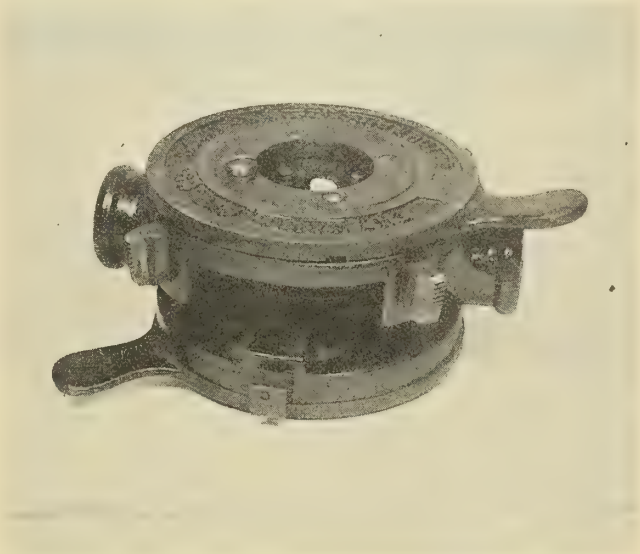


Fig. 6.—"Opening" Die Stock, or Quick-Releasing Type, With Adjustable Guide

Fig. 2.—Name Plate and 1-inch Die from Oldest Known Stock and Die

Fig. 3.—Square or Common Stock and Die

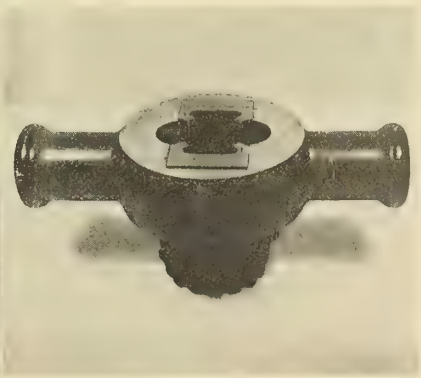


Fig. 4.—Split or Adjustable Stock and Die

* Manager Pipe Tool Department, Greenfield Tap & Die Corporation, Greenfield, Mass.

common usage and ten years later had nearly replaced the common or square die.

At this time steel pipe was attracting attention, and though more difficult to thread than iron pipe, it was making a comfortable market for itself. As is usually the case where a new condition is to be met, new ideas sprang up, each manufacturer trying to introduce a tool to meet this new condition.

Some increased the angle of cut, some introduced square or split dies with staggered teeth, while others turned to the manufacture of tools (Fig. 5) made on the now universally accepted receding die principle. This change in threading practice and unrest in the minds of users also opened the way for the round "opening" die stock or quick-releasing tool (Fig. 6).

Universal guides have to some extent replaced ring bushings and for a time it seemed that universal dies would replace dies threading only one size, but the variance in helical angles has re-established the single-size die in popular fancy. However, the users of universal dies had learned of the benefits that came from having multiple

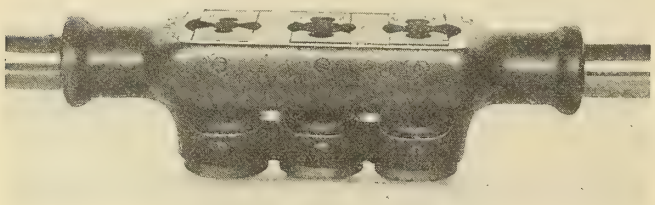


Fig. 7.—"Triple" Die Stock

sizes in one stock. This aided in the introduction of a new type of tool (Fig. 7), which has been nicknamed "triple" die stock. These tools are fitted with three sets of adjustable dies and meet the demand for several sizes in one stock without attempting to cut more than one size of pipe with each die.

The receding land principle also effected a change in power machine threading practice. Before its advent, when steam or other repairs were necessary, pipe larger than 2 inches was removed from place to be re-threaded on machines.

To-day through the use of geared receding threaders, pipe up to and including 12 inches can be threaded while in place by one man. Power machine threading has also seen the introduction of a unit motor which has made possible the mobility of larger machines. To-day it is a common thing to ship a 6 or 8-inch pipe threading machine, if equipped with an individual motor, to where the pipe is to be installed, hook it up with the now prevalent electric wires and thread the pipe on the job.

Progress in the Non-Ferrous Alloy Industry During the Last Two Decades

BY W. M. CORSE

The last two decades in the non-ferrous alloy inuustry have been marked by several distinct phases of development. First, the advent of the chemist and metallographist into the trade. Second, the exchange of information through trade journals and scientific societies. The oldest trade journal was started in 1902 and the two scientific societies, viz., the American Institute of Metals and the Institute of Metals of Great Britain, were founded in 1907 and 1909 respectively.; Third, the application of the knowledge gained to engineering problems and shop methods, both from a manufacturing and consuming viewpoint.

These three phases enabled information pertaining to the industry to be widely disseminated. This exchange of knowledge has led to many permanent advances and made possible many developments. For instance, aluminum is now a commercial article. Magnesium, tungsten, titanium and vanadium are well known and have important uses.

The effects of small additions to standard alloys have been studied and many new and valuable combinations have resulted.

The laboratory control of shop methods is an established fact. Its aids are the microscope, the pyrometer and other instruments of physical and chemical testing.

Such machines as the automobile, the aeroplane, and the internal combustion marine engine, have put such severe demands on materials of construction that a strong incentive has been given to the development of the scientific phases of this industry.

If the results of the next decade are in proportion to those of the last two, the non-ferrous alloy industry may be expected to contribute an important share of the world's development.

Oxy=Acetylene and Oxy=Hydrogen Welding and Cutting in the Marine Field

THE uses of oxygen and acetylene or hydrogen for welding and cutting, which had its commercial inception in this country about 1905 to 1906, has made rapid strides in connection with shipbuilding and its attendant industries, and is now proving a considerable factor in the development of the industry in this country.

The navy yards were the first to take up the use of the process to any large extent, and all of the large yards are now equipped with very efficient plants in which they are practically independent of outside supplies other than raw materials. They generate their own oxygen, hydrogen and acetylene, and compress the latter into dissolved acetylene tanks, so as to enable the process to be carried out anywhere in the yard or on vessels in the docks in the best and safest manner. This is such a characteristic of a navy yard equipment that welding equipments, including dissolved acetylene compression apparatus, have become known as "Navy Type Plants."

Not only are the yards equipped in this way, but the repair vessels *Dixie, Panther, Prometheus, Hancock, Vestal* and *Melville* are also equipped in a like manner, and it is to be expected that at some future date equipments will be carried on all battleships and cruisers of the navy, as it would enable numerous repairs to be carried out and the cutting apparatus would be quite a factor in removing wreckage. An instance of this is recorded in connection with the European war, where in an action before Belgrade the turret of a gunboat was struck and partly demolished so that the men inside could not get out, with the result that after the action was completed it was necessary to cut a hole in the turret to release them.

Up to this time the use of the welding process in marine construction has been largely confined to comparatively thin metals, excepting as far as repairs are concerned, small air tanks and parts of ventilating systems being welded in large quantities. The principal application of the process, however, is that connected with the use of oxygen for cutting steel. In the construction of the hull of a vessel, steel plates have to be cut very extensively

into irregular shapes, which cannot be handled by the usual shearing machinery. This work, in the past, has been carried out by methods which included the extensive use of air chisels with which the metal was cut away bit by bit until the correct contour of the plate was obtained, and this department of a shipyard was an extremely busy one. Now, however, in up-to-date yards, this department contains only a few men who do this work by means of the oxy-acetylene cutting torch.

As the work of the torch, when held in the hand of the operator, is comparatively rough, and therefore not satisfactory for a great deal of the work, a machine has

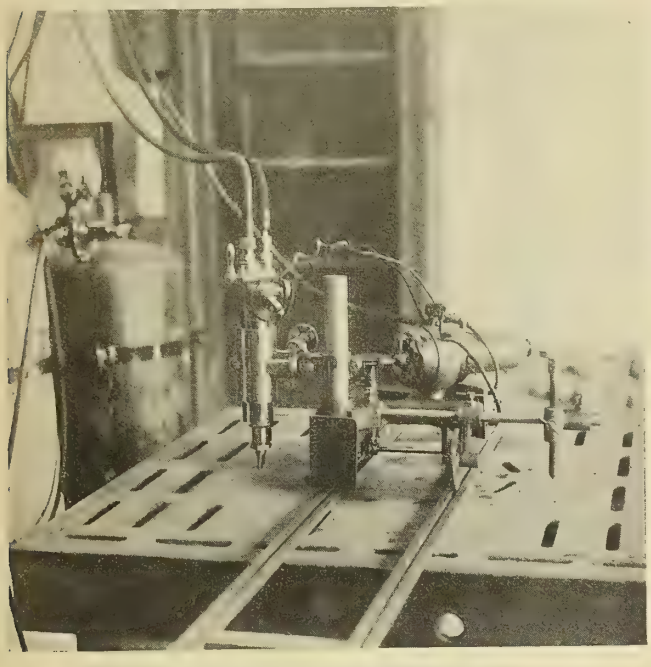


Fig. 1.—The Radiagraph

Approximate Speed of Machine Cutting

Thickness of Steel Inches	Inches Cut Per Minute
¼	18
½	16
¾	15
1	10
1½	9
2	8
3	8
4	6½
5	6
6	5
7	5
8	4
9	4

been devised which is called the "radiagraph," which holds the torch rigidly and at the correct angle and is provided with an electric motor which, driving through wheels, propels the torch along at a uniform rate of speed which can be adjusted to that giving the best results for the particular tvpe of cut on which it is being used. This machine, illustrated in Fig. 1, has proved one of the most radical developments in the method used in the shipyard so far this century, as it enables plates to be cut with sufficient smoothness and accuracy for the purpose, at speeds shown in the accompanying table, the smoothness of the cut comparing very favorably with that produced with the rougher classes of machine tools.

In addition to work directly connected with the hull, the process is being used very extensively on other parts, including the cutting of steel disks in the construction of turbines. There is, of course, a tremendous field for repair work both for the cutting and welding process, and record times have been made in putting a vessel back into service after a collision, by cutting away the damaged plates in the least possible time. Both the welding and cutting processes are used extensively in the repair of boilers, and this has greatly facilitated the repairs between trips, as the work can be carried out much more expeditiously than by the usual boiler shop methods.

Development of the Twist Drill

THE rapid strides made in marine construction during the past generation are astonishing; and to a large degree they have been made possible by improvements in the design and in the methods of use of the twist drill and other tools which have proven themselves indispensable in the upbuilding of this great industry.

Although in certain branches of marine construction the twist drill appears to be of comparatively minor importance—for instance, in plate work, where a punched and reamed hole is more common than is the drilled hole—nevertheless, in the fitting of the heavy beams and girders and in the building of machinery for the modern steamship the twist drill holds a position of supreme importance. Without it, the perfection of the modern multiple expansion reciprocating engines and steam turbines would be wellnigh unobtainable.

The drills of the early days would hardly be recognized as the forefathers of the present tools. They were made from square bars of steel, the shank forged square and tapering, and the cutting and forged flat on two sides and ground by hand (on a grindstone) sharp and to approximately correct diameter. These drills were called "diamond points." The holes to be drilled were laid out on a chalked surface by compass and prick punch, a large prick punch indentation in the center of each circle being made for the point of the drill to start in. If, as usually happened, the drill started to run to one side of the center the workman, with a round-nosed cape chisel, chipped a little groove down the side of the cone-shaped recess—to bring the drill back where it belonged. As these drills did not *cut,* but *scraped,* the drilling process was very slow.

The accuracy and high uniformity of the modern twist drill is a comparatively recent development. For many years the drill was a comparatively rough tool—turned in a lathe, the flutes milled out and the back clearance filed off or ground by hand. Then the drill was hardened and tempered and shipped just as it came from the tempering process. These early drills were seldom straight, as the metal sprung in the hardening; their surface was apt to be rough and the diameters varied according to the skill of the lathe hand. While they were a great improvement over the flat or diamond-pointed drill, as to cutting qualities, they were still handled in much the same way by the workman, and were such rough tools as practically to obviate the possibility of using them in jigs or holders, and hence in multiple-spindle drilling machines.

Our present use of the twist drill in multiple-spindle drilling machines is a strictly modern development—made possible by the fact that all twist drills are now ground all over to size after tempering and are, as to outside diameter, practically as accurate as reamers. Holes can now be drilled with a high degree of uniformimty and with great speed. As a result, the drilling job in all modern shops has been changed from the slowest and most uncertain to the most accurate and expeditious of all mechanical operations.

TORPEDO PRACTICE FROM THE DECK OF A DESTROYER

Photographs by the Press Illustrating Service, Inc., New York

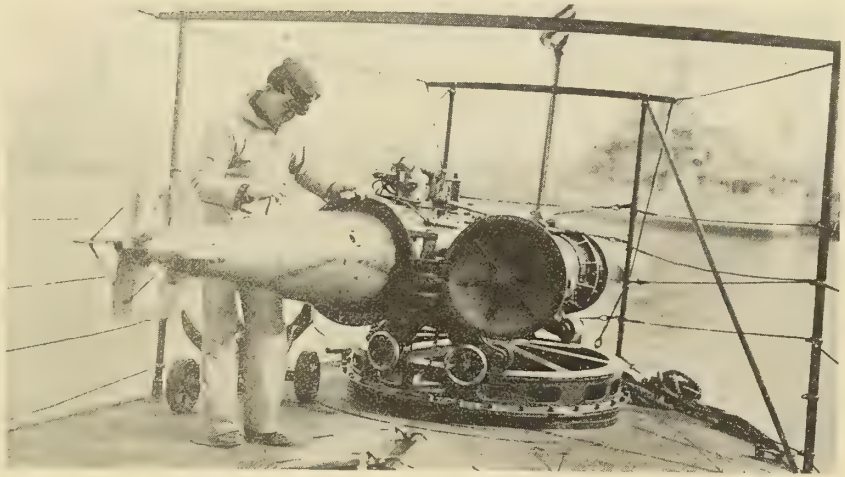


Fig. 1.—Torpedo in the Tube, Ready for Firing

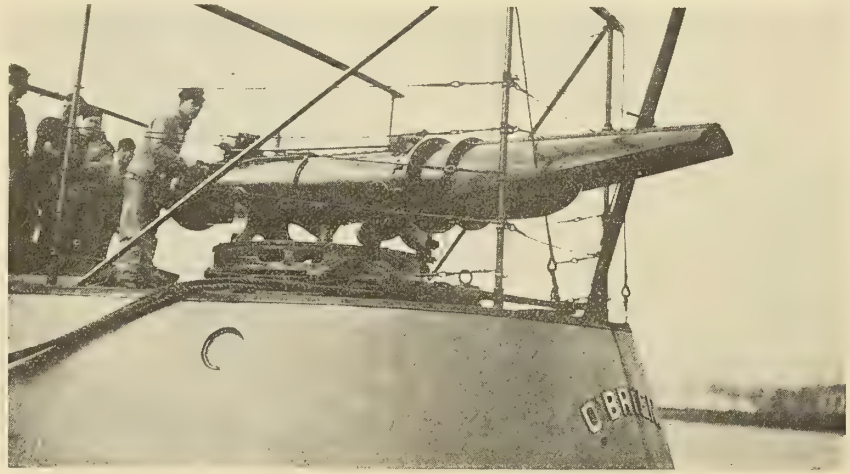


Fig. 2.—Aiming the Torpedo

Fig. 3.—Firing the Torpedo

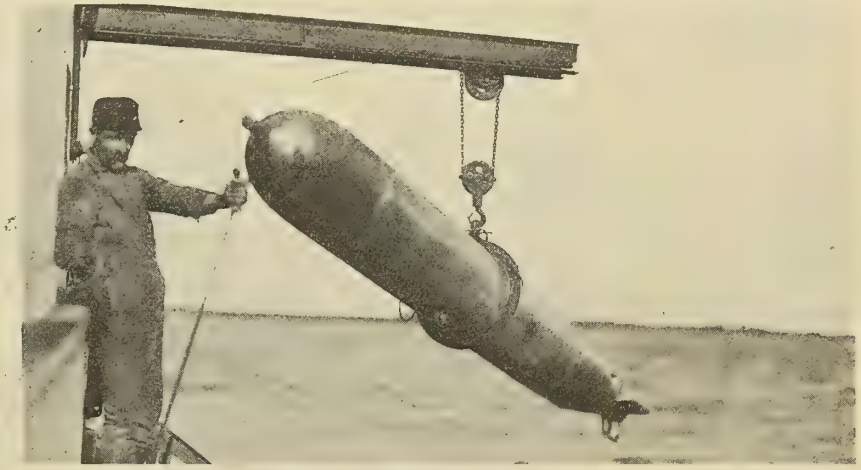


Fig. 4.—Recovery of the Torpedo

Why Is Ship Classification?

Old Mac Routs the Enemy and Shows the Boys How It is Done

ANOTHER Monday, and with it another wild idea conceived by "Old Man of the Sea"! On Saturday he had borrowed a copy of classification rules and early in the afternoon had stalked away with it and Tek's famous red book under his arm. With all this dope, a full day at home in the bosom of a worshipping family, and with lots of tobacco, something just had to come forth. It did.

On Monday morning, early, he told the Chief, in a severe and convincing way, that the riveting for the shell shown in the plans for his boat was too light; ¾-inch rivets shown must be increased to ⅞ inch, or maybe 1 inch.

The Chief was in the midst of a lot of trouble trying to straighten out some material schedules so that we might use some Belgian stock that was available. When "Old Man of the Sea" sprung his idea, the Chief sized him up with a sad, tired look and asked him please to take the matter up with Mr. Mac, adding that he hoped that such a change would not be necessary because, if it were, many a ship that was apparently all right and well built might suddenly lose her shell and of necessity sink with all on board.

"Old Man of the Sea" said that it was indeed a serious matter. He always had contended that ships were constructed too light, but in this instance he said he was backed up by the classification society.

The Chief knew that "Old Man of the Sea's" company carried their own insurance and this boat was not to be built to the society's rules, but he could see nothing but trouble ahead, and as he had plenty for the rest of the morning, he again patiently asked "Old Man of the Sea" to see Mr. Mac.

This, "Old Man of the Sea" did not want to do, because the fact that the Chief treated the matter lightly made his position less dignified. He was trying to keep clear of "Old Mac" also. He was getting "gun shy," as it were.

Mac saw him talking to the Chief, and when he started in the direction of his table he knew he was in for it. He cut off a large-sized chew and got it softened up by the time "Old Man of the Sea" got started in.

"Yes," admitted Mac, "for that thickness of plate ⅞-inch rivets should be used, but why so thick a plate?"

"The classification society requires it," replied "Old Man of the Sea."

"How do you figure it?" asked Mac.

"Well, you multiply $L \times B \times D$, don't you?"

"No, you don't," said Mac, "you add $B + D$ and multiply by L. No wonder your numeral is large. I don't see how you kept in the table at all."

"Old Man of the Sea" got red in the face. He was so mad that the back of his neck got red. Then he got white in the gills and all his pep left him. After sputtering around for a minute, he turned and stalked out, telling the Chief, as he passed his desk, that he would let the matter stand as it was for the time being. The Chief watched him go out and smiled in a relieved sort of a way.

Tek asked Stevens at noontime, "What was this classification stuff that 'Old Man of the Sea' sprung on Old Mac this morning; some high-brow dope from the Old Country? What was that book he had? I want to get it."

"Mac has the book, but I don't think you can buy it," said Stevens. "Let's ask him.

"Say, Mr. Mac, why is ship classification?"

Old Mac replied: "When it is desired to insure a ship or her cargo by a marine insurance company she must be surveyed and classified and registered in a ship classification society. The classification she gets indicates her desirability as an insurance risk and determines the rate of insurance the shipper will have to pay on the ship and her cargo. To protect themselves from losing money on a poorly-built ship or a ship in poor condition the classification society has employed a staff of capable and experienced men who through a good many years have developed a book of rules for the construction and classification of vessels. If these rules are followed by the shipbuilder, the ship will be satisfactorily classified and registered and insurance at the proper rate can be obtained.

"What concerns us here in the drawing room is properly to interpret these classification rules. This was what 'Old Man of the Sea' was referring to this morning. He made a mistake in applying these rules and tried to work backward and prove that all ships are built too light. He ought to make some rules of his own. All the other companies would get the business. From numerals determined from the dimensions of the ship, the scantlings or sizes of frames, beams, plating, bulkheads, stem and stern frame, frame spacing, riveting, equipment, etc., and, in fact, definite information concerning all the main points can be obtained. This is given for various styles of construction. These rules have become a splendid and recognized authority on shipbuilding generally.

"When a ship is built to classification rules, a midship section and a profile are submitted for approval to the classification society's representative as the builder's interpretation of the rules, or as his idea of some departure from them that may be profitable in his particular case. If approved, and if the workmanship during the construction of the ship is satisfactory to the inspector, then the desired classification can be obtained and a low insurance rate will prevail.

"Almost every large maritime country has one or more ship classification societies. In our country it is the American Bureau of Shipping, in England there is the British Corporation and Lloyds, in France the Bureau Veritas, and so on.

"To get the proper classification with the smallest scantlings is our problem."

Tek wanted to know where he could get one of these books. Mac told him to wait until next month, when the new edition would be out, and then he could have the old one.

LARGE STEEL TUG LAUNCHED FROM BALTIMORE YARD.—The Spedden Shipbuilding Company, Baltimore, Md., launched on March 13 the steel tug *Freeport Sulphur No. 2*, for the Freeport Sulphur Company, of New York. The tug is 160 feet long, 26 feet beam and 14 feet depth of hold. She will be driven by triple-expansion engines with cylinders 21, 32 and 54 inches diameter and 26 inches stroke. The boat is the second largest tug built in a Baltimore shipyard and the third largest in the towing fleet of the United States.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Training Young Engineers

How many of our young engineers come from the ranks of firemen and coal passers, and how many come from the various engineering schools? The writer, not having any statistics at hand, can only speak from observation, and feels that the largest proportion of marine engineers come from the rank and file of the engineer's force of our ships. If this be true, then it speaks volumes in behalf of the men who trained these junior engineers. There undoubtedly must have been a spirit of co-operation between the student engineer and his teachers (the engineer staff). But even with encouragement and desire to become an engineer, the practical school, in the engineer's department of a ship, is a slow, tedious and hard road, and many a lad has had the ambition of attaining that goal knocked out of him by lack of physical strength and courage to buck the fires long enough to win promotion to the next step.

Very few lads have the patience to stick to the fireroom long enough to become thoroughly conversant with boilers, their auxiliaries and proper operation, for they are anxious to get into the engine room. This part naturally appeals to them much more than the firing.

To obtain the balanced training which is required to become an efficient engineer the apprentice to the profession must, of course, receive practical training in the fireroom. The writer has in mind the manner in which some have gained a practical schooling in marine engineering, which, he believes, would in time produce more and better engineers than the hard, slow climb from the coal bunker to the chief's stateroom.

The supervising engineer of a certain line of steamers devised this plan. Four apprentice engineers were allowed each ship of the fleet; the work of instruction of one apprentice was placed in the hands of each engineer; in other words, each engineer had an understudy. It became a part of each engineer's duty to plan the training of his protégé and report his progress to the chief each month. The chief, in turn, reported quarterly to the superintendent who kept the service records of the entire ship's personnel. As each engineer had a separate station of repairs in port, the apprentice after six months with one engineer (say the third assistant) was then given to the second assistant for the next six months and to the first the next six. After this he spent one year in the company's shop or as junior engineer on one of the ships. He was then generally found qualified by examination for a marine engineer.

At sea the apprentice stood a regular watch with his instructor, taking the fires a various period, it always being impressed upon him that study must accompany his practical work. Generally, when a lad completed six months' training on one vessel, he was transferred to another of the fleet. Having some vessels fitted with turbines and oil burners, their training in some instances had to be lengthened; they were permitted to advance as fast as possible, but never until they had satisfied their instructor that they were ready. It is quite natural that some will advance faster than others.

After graduating from this practical school and obtaining his ticket the engineer is under no obligation to the company. He is free to roam at will, but the company has never had to bind any of its engineers; they are anxious to get a berth and stick to their benefactors.

Concord, N. H. C. H. W.

Passing the Buck

The chief received an order from the skipper to inspect the bunkers to ascertain the actual amount of coal on hand and to report when finished the amount required to fill up to total capacity. He told the first assistant to look after this. The first assistant did so by giving the order to the third assistant in charge of the firerooms and coal bunkers. The third assistant gave the order to the chief water tender, who, in turn, gave it to one of the water tenders. This water tender, aided by one of the firemen, inspected the bunkers (each bunker having markings in cubic feet on a predetermined scale). The capacity figures were taken by them and these figures went back through the various hands, until they finally reach the chief, who told the skipper that he wanted 925 tons of coal to fill up the bunkers to their total capacity. This was ordered, and arrived alongside in barges the following morning.

Everything went fine, until near the end of the coaling, when it was discovered that the bunkers were all full except one, which would take about 15 tons more after being trimmed or stowed. But there were still about 100 tons in the barges. Now, the coal barges had been carefully tallied and rechecked in draft, etc., so it was known that there were just 925 tons in them. The tally of coal taken on board showed about 825 tons, so immediately the skipper sent for the chief to find out why the coal was not being stowed faster. The chief told him that there must have been a mistake somewhere—either too much coal had been sent or the wrong estimate made of the coal on hand. He was ordered to find out where the mistake lay.

Then came to light the manner in which the "buck" had been passed, with the result that all hands in their turn got called "on the carpet" before the old man and warned about "passing the buck." The mistake, of course, had been made by the fireman in setting down figures given him by the water tender. The steam log in which the daily coal expenditure had been kept almost tallied with the figures shown by the bunker estimate, for each watch always handed in a little more on the coal slip than they had burned, and as this was the first time that they had filled the bunkers to capacity, it had not been brought to light before.

"Passing the buck" is all right in a poker game, but it should not be allowed to creep into the management of an engineer or other department of the ship. If any of the readers have ever reviewed the proceedings of a court trial, in which the captain, chief engineer, or other ship's officer has been tried for negligence, it will undoubtedly illustrate the meaning of "passing the buck." When a person is tried for negligence in the performance of his

duty, it is most natural to try to place the responsibility on someone else. This is what is known as "passing the buck." Many times the writer has noted the unfortunate results of this and whenever it lay in his power to correct this he has done so. A rule laid down and very closely followed by him is, that a man to deserve promotion must prove his capacity for retaining the responsibility intrusted to him and not shed it on to his subordinate to escape possible results of certain orders. The story told by the writer about estimating the coal is, of course, not a serious phase of this habit and is related only to illustrate the method. OBSERVER.

Machine Shop Kinks

Fig. 1 shows the odd way in which the slots were machined in a face plate we recently made for one of our lathes. This odd design permits of a more varied lot of

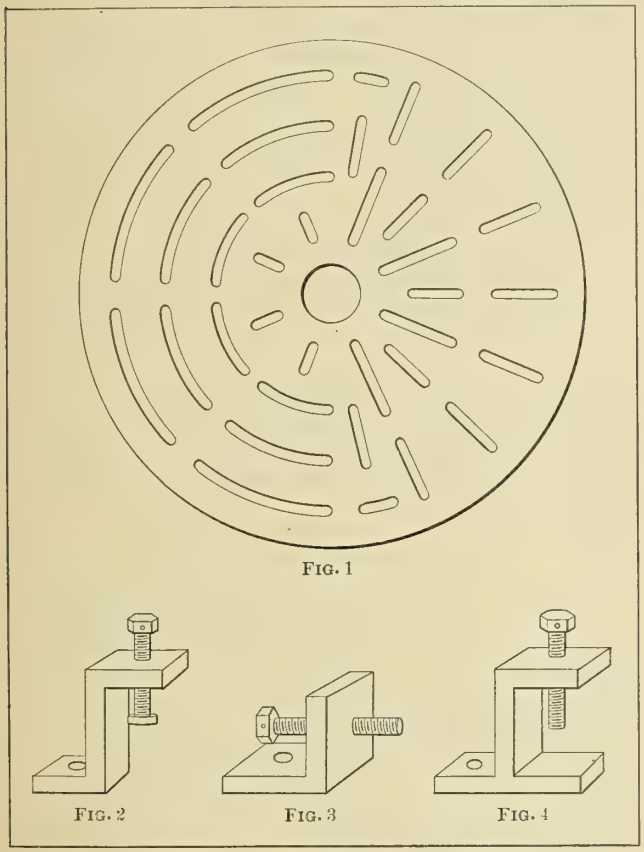


FIG. 1

FIG. 2

FIG. 3

FIG. 4

Unusual Design of Face Plate and Clamps

work to be set up on the plate than was possible on the old radial style slotted plate. The circular slots in one-half the plate have been found exceedingly handy for a large class of work found on board ship.

HANDY CLAMPS

Figs 2, 3 and 4 show some very useful clamps for holding work on the drill press table. MACHINIST MATE.

NEW PHILADELPHIA SHIPBUILDING PLANT.—The Fort Mifflin Shipbuilding Company, recently organized with a capital of $10,000,000 (£2,050,000) has purchased 160 acres fronting on the Delaware River immediately below the mouth of the Schuylkill for the erection of a shipyard. The new plant will be within the limits of the city of Philadelphia and the various shops will be combined in a single building 800 feet long by 500 feet wide.

The Bell Tapper, or Shirk

"Messenger! Did you call my relief?"

"Yes, sir. I called him 20 minutes of and he said, 'All right.'"

"Well, you go up and give him another call and tell him that it's past 4 o'clock."

The bell tapper—have you met him? If you haven't you no doubt know of him. The relief, who sticks you sometimes 10 or 20 minutes and comes down on your watch half asleep to relieve you, always with a lame excuse, generally blaming the messenger boy for not calling him—but you notice he never comes down early at any time to make it up, always creeps around at eight bells, even if he has to idle a few minutes away on top side.

The writer has noticed that this type of engineer generally has the rest of the disagreeable traits of the bum relief. Slack and poor watch is generally found at the close of his four hours. Nothing has been properly wiped down, the steam pressure is low and dirty thick fires in the boilers, hardly any relief coal is on the plates, the bilges half pumped, oil manifolds low, feed tanks in need of extra feed and, in fact, endless indications of this shirk are evident.

If the shirk happens to be your junior you can always bawl him out, but if he is your senior you generally have to swallow it. It really is surprising how these fellows do manage to hang on to their job; their salvation seems to hang on to the fact that their relief covers them up by setting things right, rather than complaining justly to the chief.

The true worth of a man is apparent when these things are noted. We have all stood these long, arduous, tiresome rough weather watches, when things went wrong and it was next to impossible to turn over a good relief and we were glad to see it drawing close to eight bells. Who can blame a fellow for feeling hot under the collar when the bell tapper or shirk sticks you? The writer feels that the shirk has no legal place in the engineer corps of a steamer and the sooner he is shown up to the chief the better it will be for the harmony of all concerned. CHIEF.

Some Notes on Oil Burning

Great care and intelligence are required for efficient results in operating fuel oil burning installations, and as the field of the oil burner is getting broader every day, both on land and sea, a few practical notes from operating engineers would no doubt be of considerable interest not only to those who are associated with fuel oil equipment but to those who like to keep posted on engineering in general.

The handling of the oil in bulk is about as safe as handling coal, but the vapor arising from it, when mixed with air, is highly explosive, and a few precautions must be taken to guard against accidents. The vapor, being heavier than air, will accumulate at low places, such as bottoms of storage tanks or compartments; and should such a mixture be allowed to accumulate, it might remain unknown until ignited by a naked light or a spark, resulting in an explosion.

Leaks of fuel oil, or drips, are therefore to be guarded against and artificial means taken to rid all low levels of any gas vapor. An empty tank or other receptacle used for storage of fuel oil should, before being entered or worked in, have all the vapor expelled by pumping it full of water and then draining it.

Do not permit any smoking, naked lights or any elec-

trical devices liable to an open spark to be within 60 feet of fuel oil pumps, tanks or piping.

If you have gage glasses fitted to oil tanks, heaters or receptacles, keep the valves closed to the glass except when a reading is desired. Should the glass leak or break with the valves open, great chances of danger are then present.

All fuel oil handling equipment should be kept wiped clean, drip pans dried out, flexible oil hose drained when not in use; or any oil spilled in cleaning the burner strainers should be wiped up. Drip pans are very good things to catch oil around the pumps or burners; they prevent the oil from running into the pits or bilge and over the floor, but the pans must be frequently wiped dry and the oil-soaked waste disposed of.

Proper fire extinguishing equipment should be installed to handle fires, steam hose connected to an always available source of supply and properly insulated for quick and easy handling, chemical fire extinguishers of large pressure tank type, a plentiful supply of fine dry sand in a handy place, with a large shovel for throwing and spreading it, are some of the means used for extinguishing oil fires.

Perhaps more people have been injured from flarebacks in lighting or operating the burners than by vapor explosions and a few words on operating the burners might help to prevent some of these accidents. The first law or rule should be never to attempt to light the oil burner of a boiler until you have made the following examinations:

If your boilers are fitted with dampers, make sure that they are wide open. If you have draft blowers, start one running to create a draft, thus reducing the possibility of a flareback. Examine the furnace to make sure that there are no puddles of oil, and blow through with steam or air. Examine the oil pressure gage to see that it is registering. You should have a pressure of about 200 pounds. Examine the burner, and if you are satisfied that the strainer is clean and the burner tip clear, you are ready to light off. In lighting the burner of a dead boiler, use a torch. Take an iron rod, or piece of pipe 4 feet long, make a waste torch, and secure to the end; soak the torch in oil, light this, and then open the oil to the burner. (The center burner of a group should be the first one lighted.) Open the air regulating valves of the registers wide to allow all air possible for lighting off. Hold the lighted torch close to the burner tip, open the oil supply full, and the burner should light. Bear in mind to stand well back, and use the 4-foot torch.

After lighting the first burner, regulate the draft, and light off the remaining burners, as many as needed, regulating the air-vane openings to control the draft and prevent the panting of the boiler and formation of smoke.

Never light more than one burner at a time, and always the center one first. The wing, or right and left-hand burners of the set should be the last ones to be ignited and the first to be extinguished when shutting down.

If the oil heater is in operation at the time of lighting off, the torch can be held up to the open air vanes instead of the burner tip.

After one burner is in operation the one near it can be lighted without the use of a torch, if the furnace is hot. I have always preferred the use of a torch. *Do not try to light* an oil burner from a *red hot bridge wall*—it has been done, but should you fail to light it there is at once generated dangerous explosive gases that will flare back. Never take any fool chances in handling the oil burner—it might cost you your life, and you might kill someone else.

If, when you are trying to light off a burner, your torch goes out, shut off the oil immediately and do not attempt to relight the burner until you are sure that the furnace is clear of gases by blowing through it with air or steam. If you do not do this, your burner will drip oil on the furnace floor and some of the oil spray will mix with the air, forming highly explosive gas, and any attempt to relight the burner will ignite this and explode it. The same applies to relighting a burner which has been burning and become extinguished.

Burners sometimes go out, due to the tip becoming plugged with some foreign substance, or the oil becomes broken down and carbonized, due to overheating in the oil heater; it should never be heated to more than 110 degrees F. Sometimes water gets in the oil supply; this causes the burners to become extinguished. No matter what causes a burner to go out, always find the cause and use the precautions described before trying to relight it.

Clean out your oil strainers often, once every eight hours is sometimes required; of course, a great deal depends on the quality of the oil. Much of the success of oil burning depends on the oil pumps; they must deliver a constant steady pressure to the burners. Air chambers fitted to the discharge side of them are valuable; in fact, absolutely necessary for properly burning the oil. These air chambers should be kept charged up with plenty of air pressure, about 80 or 90 pounds gage pressure. Fuel oil absorbs the oxygen of the air quite rapidly, therefore considerable attention should be given to these air chambers. It is usually the practice to also install them on the dead ends of the burner supply lines; they aid in removing the pulsation of the pump when properly charged up with air.

Pack the plungers of your oil supply pumps with a white metal, or lignum vitæ packing. Metal disk valves are the best for oil pumps, and last longest. The valves and cylinders of the oil end should be examined and cleaned often and regular. C. H. W.

Education of the Marine Engineer

Recently a committee was appointed by the council of the Liverpool Engineering Society to inquire into the education of the marine engineer, with a view to improving his general educational status and efficiency, and so enabling the keen competition in the future to be coped with by this important branch of the mercantile marine, and to formulate recommendations which will fulfil this object.

The committee's investigation of the subject was carried out along lines suggested by the following questions:

(1) Are the present qualifications for first and second class certificated marine engineers, as at present laid down by the Board of Trade, satisfactory?

(2) In what ways, if any, are these certified engineers, taking the class as a whole, considered to be deficient?

(3) Does the system of examination at present adopted by the Board satisfactorily ensure that the engineer may be said to have the knowledge described in the printed qualifications

(a) as to actual manual practical training;

(b) as to knowledge of principles of action and details of construction of marine engines—main and auxiliary?

(4) What are the supposed reasons for the deficiencies of the system?

(5) What remedies can be suggested and recommended for establishing a satisfactory training during school and apprenticeship stages?

(6) What course should be taken and what are the

proper bodies to approach to endeavor to bring these recommendations into effect?

The committee, after careful deliberation, unanimously came to the conclusion that the present regulations were not entirely satisfactory. They were not such as to insure that a certified man was capable of intelligently controlling and overcoming many of the difficulties presented by the main or auxiliary machinery and the boilers of modern steamers. This opinion is not held of the engineer holding an extra first class certificate, but refers to the ordinary second and first class certificated engineer. As the majority of first and extra first class certificates are obtained subsequent to a second class certificate, it was only logical to consider, first, the qualifications for the second class certificate. It was very quickly established that at this stage in the test of the engineer's qualifications there was most need of reform. The committee are agreed that the fundamental weakness of the marine engineer as a class lies in his lack of general knowledge of English, mathematics, physics and applied mechanics, and consequently a notable lack of general intelligent reasoning power, which has now become essential for the satisfactory control of the increasingly complicated machinery utilized in ships of the mercantile marine.

Evidence has been adduced of the inability of certificated engineers to make simple reports or returns, simple entries for the log, to read a revolution counter, and carry out other simple but important operations which could readily be done with even a small power of reasoning.

The committee consider that the examination papers set by the Board of Trade do not satisfactorily fulfil that object, for although the syllabus of subjects is on the whole satisfactory, the type of question appears to have become so stereotyped that it is possible for a candidate who attends a "cramming school" specially devoted to the cramming of engineers to obtain Board of Trade certificates to answer these questions outwardly in an intelligent manner, but actually without real knowledge of the subject. The committee do not underestimate the difficulty the Board of Trade has to meet in holding examinations for the same subject and purpose so frequently without more or less repetition of questions, but are of the opinion that the general qualifying regulations can and should be so framed that only the candidate with a competent knowledge, coupled with good reasoning power, shall be able to obtain his certificate, with the result that the "crammed production" will be eliminated.

The reasons for the alleged deficiency of the system lie, it is unanimously considered, in the defective early training of the candidate and the lack of opportunity and incentive.

The committee, therefore, devoted themselves to drawing up a scheme which would tend to remedy the palpable needs of the mercantile marine engineer. The recommendations which are made will no doubt appear very radical, but the committee are convinced that they will, if adopted, render the service more efficient, a result which will be of actual benefit to the officer, the shipping industry and the community. These are embodied in the following, setting out the qualifications for second class certificates:

Qualifying Certificates for Second Class Engineers of Steamers of Not Less Than 100 Nominal Horsepower, as Defined in the Board of Trade Regulations.

A candidate for a second class engineer's certificate must

(a) be not less than twenty-two and one-half years of age,

(b) have served as an apprentice engineer for five years at least, or, as an equivalent, three years as an apprentice engineer and three years at approved technical school or college,

(c) produce testimonials to the satisfaction of the Board of Trade,

(d) in addition to the apprenticeship as described below, have served eighteen months at sea as engineer on regular watch on the main engines or boilers of a foreign-going steamer of not less than sixty-six nominal horsepower, or twenty-seven months in a home-trade steamer of not less than sixty-six nominal horsepower.

It must be shown that during the five years' apprenticeship under requirement (b) the candidate has been employed in the manner set forth below:

(1) No service as apprentice prior to the age of sixteen will be recognized as part of the specified minimum period of apprentiseship.

(2) Workshop service in works where engines and boilers are made and repaired. Not less than two years of the apprenticeship must have been spent at fitting, erecting, or repairing engines and machinery either in the works or outside. The remaining three years may have been made up of time spent (1) in engine works at fitting, erecting, or repairing engines and machinery, or (2) at one or the other trades described below, or (3) at an approved technical day school or college, and, in this case, in the workshops for an additional period of one year.

The time spent in the workshops shall be counted as follows:

Fitting, erecting, repairing, or turning-full time.

Working in drawing office, full time up to one year; beyond one year, half time.

Pattern making, full time up to six months.

The main principles underlying the recommendation are, first, the creation of a new class of engineer who is not a bona fide mechanic, having served no apprenticeship and is simply a handy man who has made himself efficient to a certain extent by experience derived from his familiarity with a certain type of machinery, and who will not be granted a certificate, but a license to serve as engineer or watch-keeper in certain low-powered vessels; second, the essential establishment of a requirement to be met in obtaining a second class certificate, making attendance at schools of approved character during the period of apprenticeship compulsory. The result of the committee's recommendations, therefore, will be to draw a distinct line of demarcation between the certificated engineer and the licensee, and, moreover, generally speaking, to discountenance, in respect to the second class certificated engineer, sea service as an equivalent to general knowledge of the principles of marine engineering without in any way sacrificing the qualifications necessary to enable the certificated engineer to carry out personally or supervise emergency repairs at sea.

The investigation and recommendations by the committee of the Liverpool Engineering Society emphasize the great need of help from our Federal Government for the education of marine engineers in the United States. Uncle Sam should assist our marine schools at New York, Buffalo, Cleveland, Milwaukee, and other cities. Help could be given these schools by the appointment of an instructor detailed from the Navy, Coast Guard or other service.

The need for machine shop practice is also urgent. Even one month of such experience would be a great help, and our schools for the instruction of applicants for a marine engineer's license should make arrangements with machine shops, so that the applicant can at least have some drill with machine tools.

Marine Engineer.

NEW BOOKS FOR MARINE ENGINEERS

Practical Marine Engineering. Fourth edition. Revised and enlarged. By Capt. C. W. Dyson, U. S. N. Size, 6 x 9 inches. Pages, 982. Illustrations, 550. New York, 1917: Marine Engineering. Price, $6.

The first edition of this book, published in 1901, was written by Professor W. F. Durand, at that time head of the department of naval architecture and marine engineering at Cornell University. Since that date the book has run through three editions, with some minor changes and additions to cover new developments in marine engineering. The new edition, however, has been thoroughly revised and entirely rewritten by Captain C. W. Dyson, of the Bureau of Steam Engineering, United States Navy Department, one of the foremost authorities in steam engineering and marine propulsion in the United States to-day.

In the new edition those parts of the original book dealing with the fundamental principles of marine machinery have been retained, but the order of treatment has been changed, so that the various parts of the book have been brought together to form one connected book of fifteen chapters. Much new material has been added in order to bring the book thoroughly up to date, although the recent advance in marine engineering has been so rapid that it has been necessary to make the descriptions of new machinery and appliances as short as possible. The new matter deals principally with such subjects as steam turbines, improved watertube boilers, fuel oil burning, superheated steam, oil engines and a great number of auxiliaries which have recently been perfected and are generally adopted in modern marine practice.

The original purpose of this book, to provide help for the operative or practical marine engineer, either for the man who has already entered the profession, who may wish to perfect himself more fully in many branches of the subject, or for the applicant for the lowest round of the ladder or for the young man whose attention is first turning to this field, and who may wish some simple and fairly complete presentation of the subject from a practical standpoint, has not been deviated from. The treatment of the subject throughout has been with a view to simplicity, and only such parts of the general field of engineering have been included as are of special interest to the practical marine engineer. No attempt is made to treat of the designing of marine machinery except in an incidental way, but the topics of construction, operation, management and care, which are of paramount importance to the practical engineer, have been covered thoroughly.

Materials of engineering construction and fuels are first taken up; then the latest types of marine boilers are described, together with superheaters and accessories. In this connection the latest rules of the United States Board of Supervising Inspectors of Steam Vessels for the construction of steam boilers have been given in full. The chapter on oil fuel burning is practically new and not only describes the latest types of fuel oil burners, but also the methods of operating an oil-fired boiler.

While the marine engineer sixteen years ago was concerned only with the reciprocating steam engine, to-day he must be familiar also with the construction and operation of steam turbines, internal combusion engines, both of the explosive and of the Diesel types, and their various accessories. All these classes of propelling machinery are described in detail, together with the special auxiliaries required for each type, as well as many new auxiliaries which have recently been perfected.

In the chapter on operation, management and repair, which is of special interest to the practical marine engineer, much new valuable information is given regarding the operation of turbine-propelled vessels. The subject of steam engine indicators has been amplified by a section on torsion meters for determining the horsepower of turbines.

The book contains a collection of miscellaneous problems and discussions, many of which will be of value to the professional engineer in connection with the various questions likely to arise in his experience. At the end of each chapter are questions, with a page reference to the part of the book where the answer to each question may be found. It is believed that the subject matter thus presented will be extremely useful to an applicant for a marine engineer's license, as the subject matter on which such examinations are based is thoroughly covered in language which can easily be understood.

Design of Marine Engines and Auxiliaries. By Edward M. Bragg, S. B. Size, 6 x 9 inches. Pages, 183. Illustrations, 110. New York, 1916: D. Van Nostrand Company. Price, $3 net.

This book is an enlargement of a previous work by the same author which originally appeared as a serial in Marine Engineering. The book is divided into five sections dealing with the determination of cylinder dimensions, design of engine parts, engine balancing, condensers and air pumps and turning engines and reversing engines. The only parts of the book for which the author claims originality are the method of design, method of obtaining mean bearing loads, the use of the mean lead in the solution of valve diagrams, the method of designing condensers and the method of designing turning engines. The methods described are thoroughly workable; in fact, the whole treatise is one which can be readily accepted as a convenient and accurate guide for the calculations which it covers. Designers of marine machinery will find the work of great value as well as students or draftsmen who are taking up engine work in shipyards.

Johnson's Steam Vessels of the Atlantic Coast, 1917. By Eads Johnson. Size, 8 x 4½ inches. Pages, 240. New York, 1917: Eads Johnson Publishing Company. Price, $5.00.

This book is an annual publication containing a complete and accurate list of the mercantile steam vessels of American Registry on the Atlantic seaboard, together with the main particulars of each vessel arranged in such form as to be convenient and instantaneously available for reference. First is given an alphabetical list of the steamship companies and owners of vessels; then an alphabetical list of each vessel with the owners' name, supplemented by an alphabetical list of former names of vessels listed in the book and, finally, the particulars of all of the vessels of the various fleets arranged alphabetically according to the name of the owner.

Submarines: Their Mechanism and Operation. By F. A. Talbot. Size, 5 x 7¼ inches. Pages, 274. Numerous illustrations. Philadelphia, 1915: J. B. Lippincott Company. Price, $1.25 net.

This book was written essentially for the general reader who desires to acquire a rudimentary knowledge of the construction and operation of submarines. It describes particularly the Lake and Holland types of submarines, together with the machinery used for both surface and submerged propulsion. Interesting chapters deal with the testing and salvage of submarines. The book is clearly written, splendidly illustrated, and apparently based upon an accurate knowledge of the subject.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Size and Pitch of Rivets in Boiler

Q. (869).—What size rivets should be used for a boiler plate 26/100 inch thick and how far apart should they be spaced?

A (869).—First find the minimum diameter of rivet, by equating the resistances for shearing rivets to tearing of plate (single riveted butt joint assumed).

$$(p - d)\ tf_t = (p - 2d)\ tf_t + \frac{\pi d^2}{4} f_s,$$

$$d = \frac{4tf_t}{\pi f_s} = \frac{4 \times 0.26 \times 55{,}000}{\pi \times 45{,}000} = 0.405 \text{ inch.}$$

Use 5/8-inch rivet diameter as minimum. Then from Table X, p. 160,† the maximum allowable pitch is 1.72 inches.

Answer: Pitch maximum allowable, 1.72 inches. Diameter is 5/8 inch.

p = pitch of rivet in inches,
d = diameter of rivet in inches,
t = thickness of shell plate in inches,
f_t = 55,000 pounds per square inch,
f_s = 45,000 pounds per square inch.

Strakes of Shell Plating

Q. (864).—To settle a dispute, will you please name the strakes on ships of old and new construction? Also give method of getting constant for working out horsepower, and give example?

A (864).—The question is vague, in that it does not specify what part of the ship is under discussion, whether shell, deck, inner bottom, etc., but assuming that it refers to the shell plating of a steel ship, there has been no change in the naming of those strakes which commonly receive specific names, such as keel, garboards, bilge, and sheer strake.

Horsepower is computed from the following expression:

$$I.H.P. = \frac{2PLAN}{33{,}000}$$

where P = mean effective pressure from indicator diagram in pounds per square inch,
L = length of stroke in feet,
A = area of piston in square inches,
N = number of revolutions per minute.

For a given cylinder A and L are the same so $\frac{2LA}{33{,}000}$ can be computed once for all, called the engine constant, and simply multiplied by the mean effective pressure and revolutions per minute to get the horsepower for those runs. In accurate work allowance should be made for the area of the piston rod, or tail rod, as the A in the formula is always net area. A single cylinder engine of 18-inch diameter by 24-inch stroke, with piston rod of 2 inches, has the following returned trial data:

Run No.	1	2	3	4	5
M. E. P. (average of both ends).	10	35	60	80	90
R. P. M. (average of both ends).	50	65	78	90	100

the area of the head end is

$$A_h = \frac{\pi \times 18^2}{4} = 254.5 \text{ square inches;}$$

subtracting the area of the piston rod, the piston area for crank end, is 254.5 — 3.1 = 251.4 square inches. The average of both ends is 505.9, divided by 2 = 252.95, use 253.0, the engine constant is then

$$\frac{2 \times \frac{24}{12} \times 253}{33{,}000} = .03067;$$

the horsepower, then, for the various runs will be:

$C \times P \times N = I.H.P.$

Run 1.....	.0367 x 10 x 50 =	18
2.....	.0367 x 35 x 65 =	83
3.....	.0367 x 60 x 78 =	172
4.....	.0367 x 80 x 90 =	264
5.....	.0367 x 90 x 100 =	330

Wake Gain and Thrust Deduction

Q.—Will you please explain what is meant by "wake gain" and "thrust deduction"? N. S.

A.—If a vessel without propeller were propelled at a speed V_s by an external force applied at the thrust block, the push would be just equal to the resistance (R) which the vessel would offer to being towed. The useful or effective horsepower is then E. H. P. $= R \times V_s \times .00307$.

If a vessel, with a propeller operating at its normal R. P. M. behind it, is propelled by an external force applied at the thrust bearing at such a rate that the propeller exerts no thrust, the force required (T) will be equal to that which the propeller is delivering, but larger than the resistance (R) by the suction of the column of water drawn from the hull to the propeller. This added resistance is expressed as a percentage (t) of the total thrust (T), so that the thrust at the thrust block is

$$T = R + t\ T = \frac{R}{1 - t}$$

The horsepower to drive the ship is this thrust multiplied by the distance it moves through and by a constant, so that the thrust horsepower or horsepower applied at the thrust block is

$$T.H.P. = T \times V \times .00307 = \frac{.00307\ V_s \times R}{1 - t};$$

but

$$.00307\ V\ R = E.H.P.,$$

so

$$T.H.P. = \frac{E.H.P.}{1 - t}$$

Obviously, if there is no propeller acting there is no thrust deduction, and then $T.H.P. = E.H.P.$

A propeller operating in still or flowing water receives

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

† "Design of Steam Boilers," Haven & Swett.

the power, *S. H. P.* (sometimes expressed as gross horsepower, *G. H. P.*) and delivers the useful power of *S. H. P.* × Eff. of Propeller.

This useful horsepower is a function of the thrust of the propeller times the distance through which it acts in a unit of time. This latter is the speed of advance (V_a) of the propeller through the water surrounding it, so that we may write,

$$S.\,H.\,P \times Eff_p = \text{thrust} \times .00307\,V_a$$

and the propeller thrust is then

$$T = \frac{S.\,H.\,P. \times Eff_p}{.00307\,V_a}$$

The thrust that the propeller gives must be equal to the thrust required at the thrust block to propel the ship with a propeller operating in place. This has been deduced as

$$T = \frac{R}{1-t}$$

therefore

$$\frac{S.\,H.\,P. \times Eff_p}{.00307\,V_a} = \frac{R}{1-t}$$

When the propeller is working in place behind the ship, it is in the wake, which has a speed forward of w expressed as a percentage of the speed of the ship, so that the speed of the propeller through the water surrounding it is,

$$V_a = V_{ship} - V_{wake} = V_s - wV_s = V_s\,(1-w),$$

$$\text{then } S.\,H.\,P. = \frac{.00307\,R\,V_s\,(1-w)}{Eff_p\,(1-t)}$$

$$= \frac{E.\,H.\,P.}{Eff_p} \times \left(\frac{1-w}{1-t}\right)$$

$$E.\,H.\,P. = S.\,H.\,P. \times Eff_p \times \left(\frac{1-t}{1-w}\right)$$

$\frac{1-t}{1-w}$ is termed the hull efficiency (E_h)

and

$$E.\,H.\,P. = I.\,H.\,P. \times Eff_{eng.} \times Eff_{prop.} \times Eff_{hull.}$$

Power Delivered by Chain of Gears

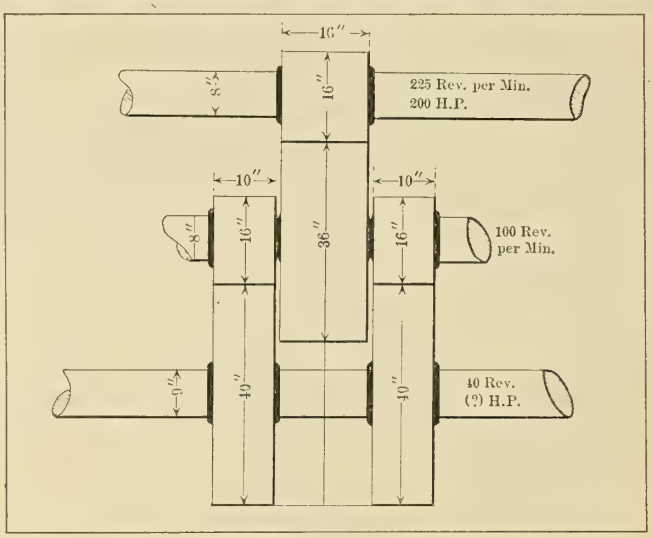
Q. (863).—The acompanying sketch represents a chain of gears. What horsepower is developed by the 9-inch shaft? Also, what is your opinion as to the sizes of the several gears as shown in the sketch? The top 8-inch shaft is a fixed quantity, as is also the 225 revolutions. The desired number of revolutions for the bottom, or 9-inch shaft, is anywhere from 40 to 50.

A (863).—If we neglect frictional losses the horsepower delivered by the 9-inch shaft is exactly the same as that put in by the 8-inch shaft. "Power" is the *work done per unit of time,* and "work is the force acting multiplied by the distance through which it acts. In dragging a weight over the ground by a horizontal pull of 100 pounds, when it had moved 10 feet there would have been 10 × 100 = 1,000 foot pounds of *work* performed. Now, if this has to be done in one second the *power* necessary would be 1,000 foot pounds *per second,* or (as 550 foot pounds per second are called, 1 horsepower),

$$\frac{1{,}000}{550} = 1.82 \text{ horsepower.}$$

If, however, the work was done in one-tenth of a second instead of a second, while the *work* would be the same, the work per unit of time or power would be 1,000 × 10 = 10,000 foot pounds per second, or 18.2 horsepower.

In your problem the work done is exactly the same on the driving and driven shaft (neglecting friction), for it is impossible to create energy. The only difference is in the component parts, those of the driving shaft being a small torque (or force), which moves through a large distance (revolutions per minute), and those of the driven end, a large torque moving through a small distance. The revolutions are correct for the pitch diameter given and, neglecting friction, the horsepower output will be 200 at 40 revolutions per minute. Well-cut gears have small frictional losses, but considering friction the output should be about 95 to 98 percent of the input, or from 190 to 196 horsepower at 40 revolutions per minute. The size of driven shaft, however, needs correction. If we accept the driving shaft as correct for the power and revolutions



Sketch of Train of Gears

per minute given, then the driven shaft should bear the following relation to it:

$$\frac{(\text{Diameter of driving shaft})^3}{(\text{Diameter of driven shaft})^3} = \frac{\text{R. P. M. driven shaft}}{\text{R. P. M. driving shaft}}$$

This would give for the proper size of driven shaft

$$\frac{8^3}{D^3} = \frac{40}{225}$$

$$D^3 = \frac{512 \times 225}{40} = 2{,}880$$

$$D = 14.2 \text{ inches}$$

instead of the 9 inches quoted. The above is for solid shafts; if the shaft are hollow the relation is

$$\frac{D^4 - d^4}{D},$$

where D and d represent the outside and inside diameters, respectively.

Number of Stays for Boiler Head

Q. (870).—Diameter of boiler, 42 inches; steam pressure allowed, 175 pounds per square inch; height above line for flues, 15 inches. Give area in square inches and the number of stays required to support head?

A (870).—There are insufficient data for the solution of this question; a sketch giving principal dimensions should be submitted.

Canadian Shipbuilding Boom.—With the expenditure of $100,000,000 (£20,500,000) for new merchant vessels, the appropriation of $17,000,000 (£3,500,000) more for coast patrol and other boats and the offer of big subsidies for the opening of new shipbuilding plants, Canadian shipbuilding interests are preparing for extensive developments. It is understood that large new shipbuilding plants will be established on both the Atlantic and Pacific coasts, while a large share of the new business will fall to shipbuilders on the Great Lakes. Negotiations are also in progress with a view to introducing the manufacture of steel plates and structural steel for ships in Canadian plants.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

In view of the extensive contracts now being awarded for naval construction large orders for shipyard equipment are being placed. The Newport News Shipbuilding & Dry Dock Company is expending $2,500,000 for improvements. The New York Shipbuilding Corporation, the Globe Shipbuilding Company and other shipbuilding companies are buying heavily.

On March 15 the Secretary of the Navy awarded contracts for four battle cruisers and six scout cruisers at an estimated cost for hulls and machinery of $111,500,000. Contracts for the battle cruisers were made on a basis of cost plus 10 percent, two to the Newport News Shipbuilding & Dry Dock Company and one each to the Fore River Shipbuilding Corporation and the New York Shipbuilding Corporation. Contracts for the scout cruisers were given, two each to the Seattle Shipbuilding & Dry Dock Company, the Union Iron Works and the William Cramp & Sons Ship & Engine Building Company.

Bids will be opened by the Navy Department on April 4 for fifteen destroyers, on April 11 for thirty-eight submarines, and at an early date for three battleships. Sixty 110-foot submarine chasers have been ordered from the New York Navy Yard, and bids from private shipbuilders for 200 others are now being considered.

The Secretary of the Navy is authorized by Congress to pay 20 percent bonuses for early delivery of naval contracts, and an emergency fund of $115,000,000 is available for speeding up naval construction. The 8-hour law on government work has also been suspended.

To determine the overhead charges to be paid by the Government for the construction of the five battle cruisers contracted for on the basis of cost plus 10 percent, the Secretary of the Navy has appointed the following special naval board: Naval Constructors David W. Taylor and Washington L. Capps, Civil Engineer Harry H. Rosseau, Engineer-in-Chief Robert S. Griffin and Pay Inspector David Potter.

Vice-Chairman Brent, of the Federal Shipping Board, is investigating wooden shipbuilding conditions on the Pacific Coast, where some 115,000 tons of wooden vessels are now under construction. The Board wishes to learn the possibilities of the rapid construction of a large fleet of moderate-sized wooden vessels to meet the urgent needs of over-seas commerce.

Cunard Line and Royal Mail Steam Packet Company Give Large Contracts for New Vessels to American Shipbuilders

The Cunard Line, New York office, 21-24 State street, has placed orders in this country for twenty or more freighters varying in size from 7,500 to 15,000 tons. It is impossible to secure correct information, but, so far as it can be approximated, the Bethlehem Steel Corporation, 111 Broadway, New York, will build at least six ships, to be divided up among its constituent companies—the Fore River Shipbuilding Corporation, Quincy, Mass., Maryland Steel Plant, Sparrows Point, Md., and the Union Iron Works, San Francisco, Cal.

According to reports, the Duthie Shipbuilding Company, Seattle, Wash., has contracts for "more than one vessel," and the same applies to the Ames Shipbuilding & Dry Dock Company, Seattle, Wash.

The Todds Shipyards Corporation, 15 Whitehall street, New York, is reported to have contracts for six vessels, to be built in yards of constituent companies—the Seattle Construction & Dry Dock Company, Seattle, Wash., and the Todd Shipyards Corporation, Tacoma, Wash.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., and Moore & Scott, San Francisco, Cal., are each reported to have contracts for two vessels, and the Northwest Steel Company, Portland, Ore., for one or more.

In addition to orders for vessels to be built, the Cunard Line is reported to have purchased contracts for several vessels under construction.

Another large British steamship company, the Royal Mail Steam Packet Company, 26 Broadway, New York, Sanderson & Son, local agents, is understood to have just about completed negotiations for the construction of a dozen or more large steamships in American shipyards.

Shipbuilding Contracts

Information regarding the fleet of towboats, each vessel to be about 125 feet long and to have 500 horsepower, mentioned in our March issue, can be had by addressing the Halcolm Ellis Engineering Corporation, 1482 Broadway, New York. We understand this company has the placing of the contracts for these vessels.

It is reported that the New York Shipbuilding Company, Camden, N. J., which is enlarging its plant in preparation for the construction of the battleships *Colorado* and *Washington*, will start work on four standard freight ships on its own account. According to report, two of the vessels are to be of 5,550 tons deadweight and two of 4,000 tons deadweight.

The American Shipbuilding Corporation, Spokane, Wash., has contracts to build eight lumber ships at a total cost of $2,400,000. Each vessel will be 300 feet long, and will be equipped with two Diesel engines.

Work is reported to have been begun in the new shipyard of Supple, Ballin & Lockwood, Portland, Ore., on two 4,000-ton wooden ships for the Gaston, Williams & Wigmore Steamship Corporation, New York.

The Vancouver Shipyards, Ltd., Vancouver, B. C., are building two 76-foot gasoline-engined fishing boats for the Columbia River Packers, Portland, Ore.

The Mark Johnson Yards, Leschi Park, Lake Washington, Seattle, have secured a contract for a 65-foot cruiser for N. W. Starrett. Lee & Brinton, naval architects, 22 Colman Dock, Seattle, Wash., designed the vessel.

The Ballard Marine Railway, Ballard, Wash., will build a large cannery tender and several scows for Alaskan parties.

Kruse & Banks Shipyard, North Bend, Ore., is building a lumber schooner for Oliver J. Olsen.

The McLean Contracting Company, Baltimore, Md., will build six sea-going barges for the Northern Transportation Company.

The Townsend Marine Railway & Construction Company, Boothbay, Me., has received a contract from Crowell & Thurlow Company, Boston, Mass., to build two more 200-foot, four-masted schooners.

The Sloan Shipyards Corporation, Seattle, Wash., will build four 280-foot wooden motor ships for the Clinchfield Navigation Company, 29 Broadway, New York.

The Elliott Bay Yacht & Engine Company, Seattle, Wash., has received an order from the United States Bureau of Fisheries, Washington, D. C., to build two patrol boats. Martin C. Erismann, naval architect, Seattle, Wash., designed the boats.

The Navy Department, Washington, D. C., has advertised for bids for 15 destroyers. Proposals for 38 additional 800-ton submarines will be advertised immediately.

The Navy Department will shortly advertise for bids for three 42,000-ton dreadnoughts.

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Rolph Navigation & Coal Company, San Francisco, for two 135-foot ocean-going steel tugs.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., to build four steamships. It is stated that these ships will be larger and faster than any now owned by the United Fruit Company.

W. I. Babcock, naval architect, 17 State street, New York, has designed two twin-screw steel, six-masted auxiliary schooners, each 350 feet long, for the Aluminum Company of America, 120 Broadway, New York, to be built at the yard of the Riter-Conley Company, Baltimore, Md.

W. I. Babcock has also designed four wooden twin-screw motor ships for the Clinchfield Navigation Company, 29 Broadway, New York, to be built by the Seattle Construction & Dry Dock Company. These vessels will each be 280 feet long, and will have a capacity for about 3,200 tons of coal.

The National Shipbuilding Company, organized by Capt. O. D. Trieber, Seattle, Wash., has received a contract to build a cannery tender for the Nooksack Packing Company, Portland, Ore.

The Standifer-Clarkson Shipbuilding Company, Portland, Ore., has a contract to build another wooden vessel for the Inter-Ocean Trading Company, San Francisco.

The Coastwise Shipbuilding Company, Baltimore, Md., has received a contract from the Cook-Cummer Steamship Company, Philadelphia, Pa., to build a 206-foot sea-going barge.

The Seattle Construction & Dry Dock Company, Seattle, Wash., will overhaul and repair the steamship *Admiral Wainwright* at a cost of about $40,000.

The Sun Shipbuilding Company, Chester, Pa., has received a contract from the Cunard Line for two 10,000-ton standard cargo vessels, at a cost of about $1,250,000 each. The ships will be 435 feet long, drawing 25.9 feet; they will be equipped with 2,800-horsepower reciprocating engines, developing a speed of about 10½ knots. The company now has orders for ten vessels of this type, and is employing a force of over 1,000 skilled mechanics.

The Seattle Construction & Dry Dock Company has closed a contract with the Cunard Line to build six 7,500-ton steel freighters for delivery in 1918. These ships are to be 396 feet long over all, 53 feet beam, with a molded depth of 29 feet 3 inches. They will each be powered with a 2,500-horsepower engine, driving a single screw, and steam will be supplied from three Scotch marine boilers. It is understood that the contract price is something over $6,000,000. The first ship is to be delivered in April, 1918, and the last one in September.

The Skinner & Eddy Corporation signed on March 3 a contract to build a 9,500-ton oil tanker for Eastern interests. Work will be started on this contract some time in the summer for delivery next year.

Libby, McNeil & Libby have let a contract to Standifer & Clarkson, of Portland, for a twin-screw motorship. The new vessel will be 240 feet long over all, 44 feet beam and 23 feet depth of hold. The ship was ordered for delivery for the 1918 season. She will be twin-decked, with three cargo hatches fitted with electric winches. The type of engines has not been decided. She was designed by Capt. C. J. Carlson, port captain for the Libby, McNeil & Libby Company.

Shipyard Notes

The International Shipbuilding Corporation, Ltd., capitalization $2,000,000, has just been incorporated in Montreal, Quebec. This company is reported to be backed by either the British government or British shipping interests for the purpose of establishing a large shipyard in Canada to build ships for British owners.

The Western Shipbuilding Corporation, Seattle, Wash., has taken over the partially completed plant of the People's Shipbuilding & Construction Company, Tacoma, Wash. It is understood that the company has already secured contracts to build several ships. A. B. Gellerman is president of the Western Shipbuilding Corporation, and has opened offices in the Burke building, Seattle.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has authorized improvements to its plant to cost about $850,000. The purchase of machinery and other equipment is in charge of H. P. Phelps, plant engineer, Newport News.

It is reported that the Rolph Navigation & Coal Company, San Francisco, Cal., has purchased the plant of the Bendixen Shipbuilding Company, Eureka, Cal., and will build wooden coal barges and sailing vessels.

R. T. Stone and others, operating under the name of the Terminal Co-Operative & Dry Dock Company, Oakland, Cal., have asked for a lease from the city of Oakland for the purpose of building a shipyard, floating drydock, machine shop, etc.

The Globe Shipbuilding Company has been organized by B. C. Cooke, Capt. C. A. Massey and M. L. McMahon, Superior, Wis., to build steel freighters for ocean service.

It is reported that Daniel Kern, of the Columbia Transportation Company, Portland, Ore., and John Kiernan, Portland, plan the establishment of a shipyard, and that they have received a contract to build a ship 230 feet long to be equipped with oil engines.

The Pacific Coast Shipbuilding Company has been organized in Tacoma, Wash., with the following officers: J. H. Hyde, president; E. E. Sherwood, vice-president; F. H. Murray, secretary; C. C. Dowd, treasurer, and L. H. Coolidge, naval architect.

The Ryder-Dickman Company, Red Bank, N. J., has been incorporated to operate a boat-building plant. Frank P. and E. W. Dickman, Red Bank, and Harry L. Ryder, South Orange, N. J., are the incorporators.

The Standard Shipbuilding Company, 44 Whitehall street, New York, will build a new plate shop at its plant on Shooters Island.

The Los Angeles Mercantile Marine Company, Black building, Los Angeles, Cal., is planning to lease a site for a shipbuilding plant at San Diego.

The Temple Shipbuilding Company has erected a wooden shipyard at Port Blakeley, Wash., and is understood to have received orders to build several schooners.

The plant of the Holmes Motor Company, Mystic, Conn., has been purchased by Wood & McClure, shipbuilders, City Island, New York.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., has been organized, with a capital stock of $800,000. Ernest Kreher, of Tampa, is president.

The Mifflin Shipbuilding Company has been incorporated at Dover, Del., with a capital stock of $10,000,000, and plans to build a plant on the Delaware River. The incorporators are A. J. Steelman, C. P. Cannon and C. L. Dambly, all of Philadelphia.

Johnson Porter, of the firm of Porter Bros., Eugene, Ore., is planning the construction of a shipbuilding plant at Florence, Ore.

The New London Ship & Engine Company, Groton, Conn., is making additions to its plant.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., is reported to be in the market for a number of punches and shears.

The Standard Shipbuilding Corporation, 44 Whitehall street, New York, has filed plans for a new boiler and plate shop at its plant on Shooter's Island, Staten Island, to cost $250,000.

The Chief of the Bureau of Yards and Docks, Navy Department, Washington, has received proposals for the construction of a one and one-half story machine and electric shop, 150 by 500 feet, at the navy yard, Philadelphia, at a cost of $500,000.

The Sun Shipbuilding Company, Chester, Pa., has had plans prepared for two one-story, brick and concrete additions to its plant. A one-story paint and oil house will also be erected, to be about 35 by 65 feet. The complete plant of the company, which was organized about a year ago (April, 1916), will include 50 acres of land along the Delaware River waterfront. The yard has five steel and concrete shipways.

The Biloxi Shipyard & Box Factory Company, Biloxi, Miss., is reported in the market for about $5,000 worth of equipment. Francis Brander is active in the enterprise.

The plant of the Vickers Company at Montreal is being enlarged by the addition of two covered building berths, which, when finished, will double the shipbuilding accommodation already provided. At present the company has one large berth capable of taking vessels 600 feet long. The dimensions of the new sheds will be 500 feet by 128 feet, and 400 feet by 100 feet, respectively. The sheds will provide for the building of vessels up to approximately 12,000 tons.

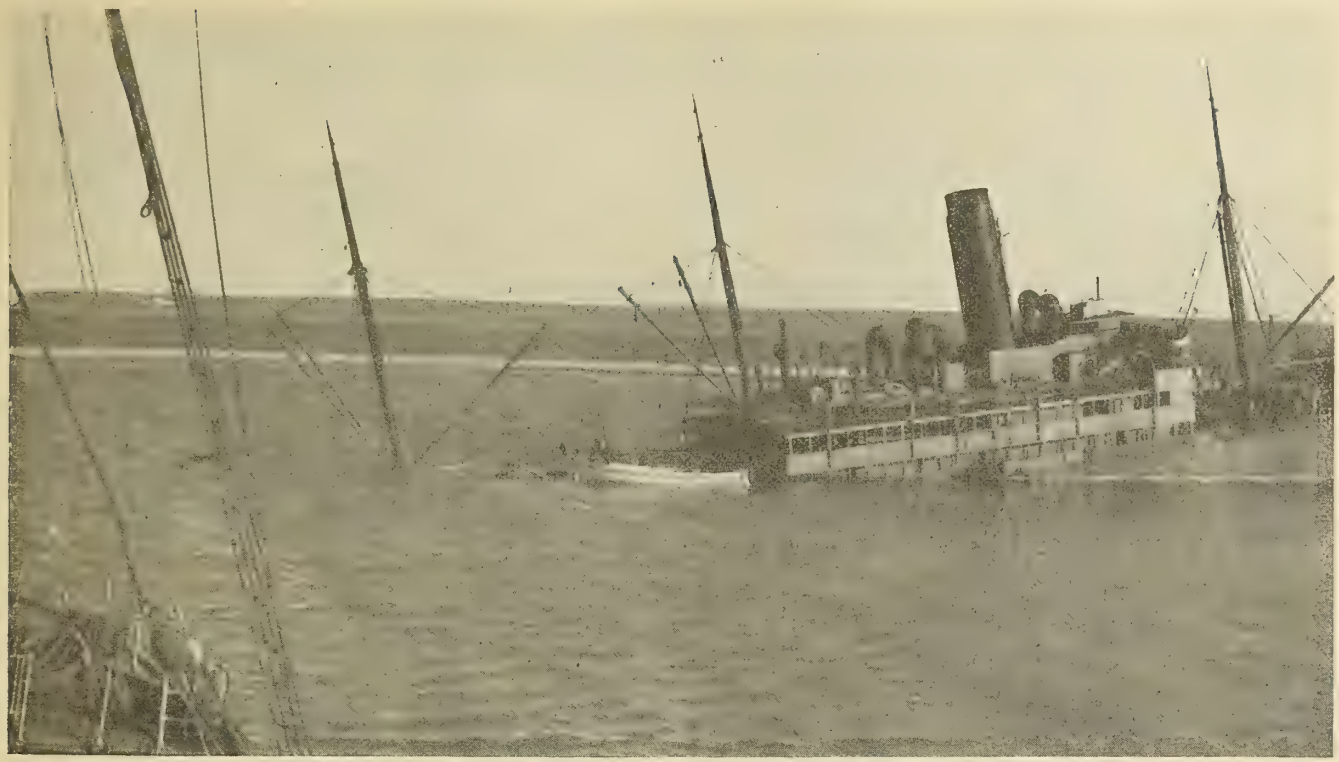
The International Navigation Corporation, Wilmington, Del., has been incorporated, with a capital of $1,000,000, to operate shipyards for the construction of boats and ships. William F. O'Keefe, George G. Stiegler and E. E. Wright are the incorporators.

The Murnan Shipbuilding Corporation, Philadelphia, Pa., has been incorporated, with a capital of $3,000,000. John F. Glenn and Samuel J. Ferguson, Philadelphia, and John Davidson, Rutledge, Pa., are the incorporators.

The New York Shipbuilding Company, Camden, N. J., is making extensions in its plant to double the former capacity. Construction has been commenced on four standard freight steamships for company service.

The Temple Shipbuilding Company has been organized and have put up a plant at Port Blakeley, Wash., for the construction of wooden ships.

The Seattle Construction & Dry Dock Company has taken out the sawmill which for so many years was a big part of the plant. This mill was equipped to turn out timbers of almost any size and was once an important part of the yard. Along with the mill went the big power plant, and in their place two new ships' ways have been laid out. A third ships' ways will be built in the slip now occupied by the big steel floating drydock. It is expected that this slip will carry the



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Ottoman Vessel, Sinking in Salonika Harbor After Bombardment by a Zeppelin Airship

scout cruiser for which plans are now being prepared.

The Ames Shipbuilding & Dry Dock Company has secured a contract for seven steel steamships for the Cunard Steamship Company. This new plant is practically complete, and the keels of the first three of these ships will be laid this month. A fourth ways will probably be built, and on this will be laid down a 9,400-ton oil tanker for the Standard Oil Company. The Ames Company also has a contract for a 9,400-ton freighter for W. C. Peagle, of Cleveland, Ohio.

The United States cruiser *Frederick* is being extensively repaired at the Puget Sound Navy Yard at Bremerton. Repairs include a new fire-directing system, a complete radio outfit and many minor changes. This yard has completed preparations for building the submarine O-2, for which they have the contract and work will be begun at once.

The Ames Shipbuilding & Dry Dock Company let the contract for their machine shop on February 16. This shop will be 420 feet long by 120 feet wide, and is the last unit of the big plant. The mold loft, power house, plate shed, office building, tool house and first building way are completed, and workmen are setting up keel blocks preparatory to the laying of the first keel. The second building way is nearly finished and the third one about half finished.

The Government navy yard at Bremerton has been working on an 11-hour schedule because of the rush of work. It was found that the men could not stand the strain of the extra hours, and the yard has dropped back to the 8-hour day.

Frank Warren, Mayor of Warrenton, Ore., is at the head of a project to raise money for the establishment of a shipbuilding plant in Warrenton.

Marine Terminal Improvements

George S. Webster, Director of Wharves, Docks & Ferries, Philadelphia, Pa., states that an appropriation of $13,300,000 has been ordered for the purchase of property and the erection of modern piers and bulkheads. A contract has already been placed for a pier on the Delaware River at the foot of Cherry street. Plans call for the construction of several new piers on the Delaware River south of Snyder avenue. Piers in other locations will also be built.

The Chamber of Commerce of the City of Columbia, S. C., has recommended that bonds for $50,000 be issued for the purpose of building a wharf and warehouse.

The Board of Control, Toronto, Can., T. McQueen, secretary, is planning to spend about $2,000,000 on a coal dock and storage building.

The Board of State Harbor Commissioners of California has let a contract to the Clinton Construction Company, San Francisco, to build pier 29 at an estimated cost of $104,000.

The Harbor Department, Los Angeles, Cal., has filed plans for the erection of an extensive series of wharves, sheds and warehouses, to cost something like a million dollars.

The City of Providence, R. I., M. H. Bransdon, city engineer, is planning to build five piers at a cost of about $800,000.

In connection with present harbor improvements, the City Commission, Trenton, N. J., has had plans prepared for a terminal dock on the Delaware River near Ferry street. With over 1,000 feet of wharf space available, the proposed work will include the erection of one-story terminal buildings on the north and south sides of the dredged basin, and the construction of open wharves along the upper section of the waterway; the structure on the north side will be provided with a second-story deck for recreation purposes. The municipal buildings will include facilities both for passenger and freight service. For freight operations all necessary labor-saving equipment for handling, storing and loading material will be installed. An initial bond issue of $100,000 has been provided for the inauguration of the work.

The City Commission, Cape May, N. J., has approved plans for the erection of a new pier on the beach front at Howard street. A convention hall will be erected in connection with the structure. The cost of the improvement is estimated at $100,000.

The Seattle Port Commission has called for bids for the construction of a storage annex to their grain elevator, which will increase its capacity from 500,000 to 1,000,000 bushels of grain in bulk. The new unit will consist of thirty storage bins 90 feet high. They will be built of concrete and will cost approximately $87,000.

Passenger Allowance on Vessels

The United States Steamboat Inspection Service has issued a circular letter, dated February 10, 1917, addressed to inspectors of the service and steamboat companies, quoting an act of Congress which was approved February 4, 1917.

The act authorizes supervising inspectors to decrease the number of passengers allowed by local inspectors to be carried on passenger vessels, except ferry boats, and requires the approval of the supervising inspector before the number of passengers allowed on such vessels can be increased. Penalties are provided for the master or owner of any vessel who knowingly allows to be carried a greater number of passengers than is stated in the certificate of inspection.

Before any passenger vessel is allowed to engage in excursions it must be provided with a special permit to carry excursion parties issued by local inspectors, and approved by the supervising inspector of the district.

Proposed Purchase of Marine Fire Pumps

Following a recent disastrous fire on the Vancouver water front, the business interests of the city have strongly urged the immediate purchase of one or two large fire boats for the better protection against fire of the buildings and wharves along Burrard Inlet. As the purchase of these fire boats is impossible at present, owing to a lack of municipal funds, it has been suggested that temporary fire protection be afforded by the installation of powerful pumps on the ferryboats operating between this city and North Vancouver. It is pointed out that during the hours of operation one of the two ferryboats would always be at or near the Vancouver shore and that during the night arrangements could be made to have one of the boats tied at the Vancouver end of the run. These ferryboats are owned and operated by the municipality of North Vancouver.

Interested dealers in marine fire pumps should communicate with the chief of the Vancouver Fire Departmnt, Vancouver, British Columbia.

Transfer of Ships

According to a report by the Bureau of Navigation, Department of Commerce, between July 1, 1914, and February 28, 1917, ships transferred to the American flag from foreign flags numbered 204 of 664,925 gross tons, and ships transferred from the American to foreign flags numbered 405 of 313,811 gross tons. The American flag made a net gain of 351,114 gross tons and a net loss of 201 vessels; in other words, American citizens bought much larger vessels than they sold.

The bulk of the American gain in tonnage has been from the British and German flags, and the Norwegian, Japanese and French flags have made the largest net gains. The following table shows the foreign flags involved and the number and gross tonnage of vessels transferred from those flags to the American flag and from the American flag to those flags, with the net American increase or decrease:

Flag	To American		From American		American Increase or Decrease	
	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Belgian	6	10,549	...	.....	6+	10,549+
British	111	357,669	170	82,651	59—	275,018+
Cuban	6	18,702	37	8,401	31—	10,301+
Danish	5	13,193	5	3,631	....	9,562+
Dutch	6	26,724	3	8,131	3+	18,593+
French	2	6,247	20	26,740	18—	20,493—
German	32	155,941	3	1,603	29+	154,338+
Greek	1	4,471	3	2,119	2—	2,352+
Italian	2	2,769	...	.....	2+	2,769+
Japanese	1	5,869	16	38,720	15—.	32,851—
Mexican	9	11,652	35	6,707	26—	4,945+
Norwegian	7	15,311	30	91,211	23—	75,900—
Portuguese	..	.....	7	3,943	7—	3,943—
Roumanian	1	5,275	...	.....	1+	5,275+
Russian	3	2,144	2	986	1+	1,158+
Spanish	..	.....	11	11,963	11—	11,963—
Swedish	..	.....	2	909	2—	909—
South Am. countries..	10	23,299	22	18,667	12—	4,632+
Central American, Haitian, Dominican, etc.	2	5,110	39	7,429	37—	2,319—
Total	204	664,925	405	313,811	201—	351,114+

Officers of Engine and Boat Manufacturers' Association Re-Elected

At the March meeting of the executive committee of the National Association of Engine & Boat Manufacturers, held at the Engineers' Club, New York City, the following officers were re-elected for the ensuing year: President, John J. Amory, of the Gas Engine & Power Company and Chas. L. Seabury & Company, Consol., Morris Heights, New York City; first vice-president, Henry R. Sutphen, of The Elco Company, Bayonne, N. J.; second vice-president, Percy C. Jones of the S. M. Jones Company, Toledo, Ohio; third vice-president, Charles A. Criqui, of the Sterling Engine Company, Buffalo, N. Y.; treasurer, James Craig, of the James Craig Engine & Machine Works, Jersey City, N. J.

The report of Mr. Henry R. Sutphen, chairman of the exhibition committee, showed that the 1917 New York National Motor Boat Show, held recently in the Grand Central Palace, was by far the most successful exhibition ever held under the auspices of the association. Substantial increases were made in attendance figures, in amount of space sold to exhibitors and in actual sales made during the progress of the show. Fifty-nine complete boats were on exhibition, ranging in size from the small useful dinghy to the new type, sixty-foot motor patrol boat, with her complete armament of rapid fire guns. A canvass of the prices of all of the boats shown placed the total value of these craft, together with the engines on exhibition, at well over $350,000. The exhibits of accessories, etc., some of the individual units of which were worth over $50,000, brought the total valuation of all exhibits at the show up to a half million dollars.

New York Barge Canal to be Opened in May

The State of New York has announced that daily service on its new barge canal will begin next May. A fleet of eight steamers and twenty-nine consorts will ply between Buffalo and Albany.

These vessels will be operated by a Syracuse company, which was recently incorporated with a capital of $257,500. Another fleet of twenty-two barges will begin operation soon after the canal is opened, and scores of remodeled Erie canal boats, it is stated, will be ready to carry freight as soon as the new State waterway is available for navigation.

It is intended that a regular schedule shall be maintained by the fleets operating in the canal. Calls will be made at all the larger cities including Rochester, Rome, Utica, Little Falls, Fonda, Amsterdam, Schenectady, Troy and Albany. Freight rates on the canal will be about two-thirds the railroad freight charges.

During the season of 1917 only package freight will be carried, but with the development of barge canal craft it is expected that all classes of freight will be received next year.

Recent Launchings

The National Shipbuilding Company launched an 86-foot cannery tender for the Sockey Salmon Company February 26. The new vessel, which will cost $20,000, is 18 feet beam, 7 feet 6 inches deep, and will be powered with a 110-horsepower Standard heavy-duty engine. This company will launch another tender this month, and has just closed a contract with Capt. Wolfe to build a 60-foot steamer for use in Alaska waters.

The submarine *N*-3 was launched from the yard of the Seattle Construction & Dry Dock Company February 22. This is the third of this type of submarine to be launched by this company this spring. The *N*-3 will be in command of Lieut. W. R. Munroe as soon as she is in commission. The *N*-1 and *N*-2 are receiving their finishing touches and will soon be ready for trial trips.

This company launched on March 14 the 7,500-ton freighter *Golden Gate,* building for Knute Knutsen, of Haguesund, Norway. The *Golden Gate* is 396 feet long, 53 feet beam and 29 feet 3 inches deep. Power is furnished by a 2,500-horsepower triple-expansion engine, with cylinders 24 inches, 40 inches, 70 inches by 48 inches stroke and three Scotch marine boilers. She is designed for a sea speed of 11 knots. Her sister ship, the *Key West,* which is building for the same company, will be launched on April 11. A third vessel of the same type will be launched in May.

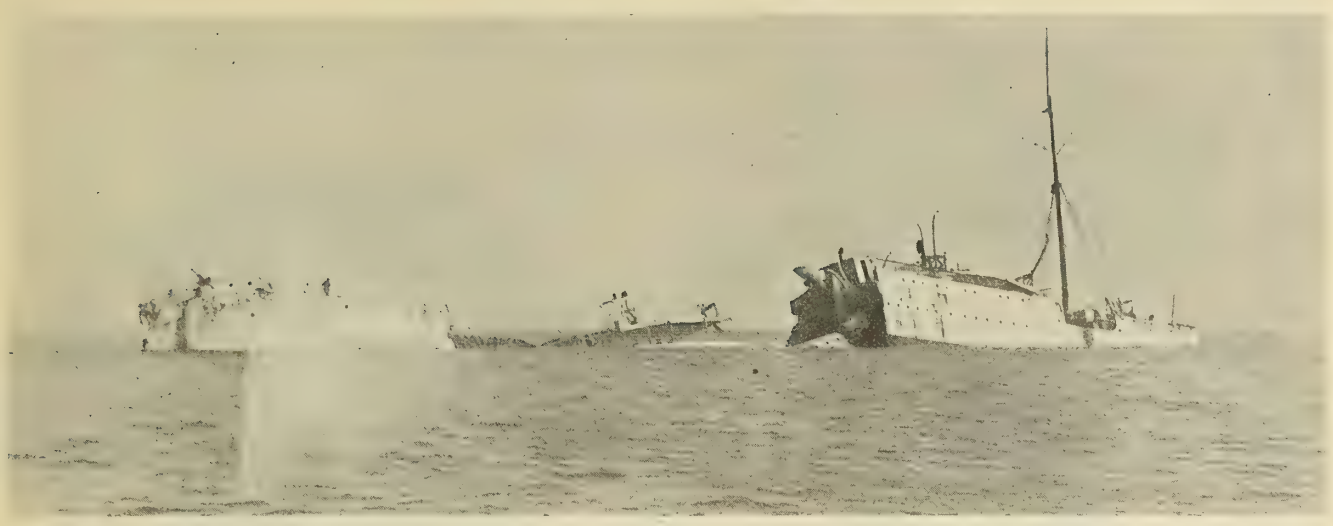
The Skinner & Eddy Shipbuilding Corporation, Seattle, Wash., launched on March 22 the steel tanker *S. V. Harkness,* which they have been building for the Standard Oil Company, and in April they will launch her sister ship the *Joshua Macey* for the same company. Their next ship off the ways will be the *Stolt-Nielsen,* which will be launched some time in June. This ship is a sister ship to the *Nels Nielsen* and *Louise Nielsen,* already described in Marine Engineering.

The *Louise Nielsen* underwent her trial trips on March 8, and, although the contract calls for only 11 knots, she made 13½ knots consistently, and on one occasion went over the course at a little better than 14 knots. As this was the first day steam had been turned into her big turbine the record is very good. The *Louise* has been chartered to the Frank Waterhouse Company, and started loading for the Orient on March 10.

Chester Shipyard Reported Sold

Negotiations have been completed for the sale of the Chester Shipbuilding Company, Chester, Pa., to a British syndicate, according to reports from Philadelphia. The purchase price is understood to be $3,000,000, which is estimated as a profit of 200 percent on the original investment. The plans of the new owners are said to include the enlargement of the yard and the construction on an extensive scale of steamers for the transatlantic trade.

The Chester Shipbuilding Company was organized about a year ago to take over the old Roach plant at Chester.



(*Copyright by International Film Service,* 1917)

United States Army Transport *Sumner* Breaking Up Off Barnegat Light, Showing Condition of the Vessel on March 10

Opportunity for Wooden-Ship Building

The Chamber of Commerce of Apalachicola, Fla., solicits correspondence with the builders and owners of wooden vessels, mainly schooners. Timber abounds in the neighborhood.

Nautical School Ship Established by State of Washihgton

The Washington State Legislature, just adjourned, passed a bill authorizing the establishment of a State nautical school ship in Seattle. The Legislature also voted to provide $25,000 a year for the maintenance of the school.

This school comes under the act of Congress establishing seven such schools and appropriating $25,000 a year for each to help maintain the vessels which will be used. The school ship's students will be trained as navigators under the supervision of United States naval officers.

World's Largest Coal Pier Opened

The Baltimore & Ohio Railroad has opened for service its new export coal pier at Curtis Bay, Baltimore, Md., harbor, March 8. The pier, said to be the largest structure of its type in the world, has been in course of construction since February, 1916, and represents an investment of about $3,500,000. It has a capacity of 12,000,000 tons of coal a year, or a maximum of 7,000 tons an hour. Of steel and concrete construction, the structure is equipped for electric operation in all departments, including a system of car unloaders, belts and towers. At maximum operation it is possible to work on four vessels with cargo and bunker coal at the same time.

Record Charter Rates

A record in charter rates was established the last week in February when the American-Hawaiian liner *Kentuckian* was chartered to operate between New York and South American ports at a rate of $97,000 per month for twelve months.

High Cost of Steamships

The high cost of steamships was shown on March 6 when the steamship *California,* formerly the *Algoa,* was sold in San Francisco for $1,500,000 by John A. Hooper to New York interests.

This vessel once took the largest consignment of lumber ever taken in one shipment from the Pacific Coast, when she carried 6,500,000 feet from the Columbia River to Sidney. The charter rate for that trip was 6 shillings 9 pence, and the present rate for the same trip is 120 shillings.

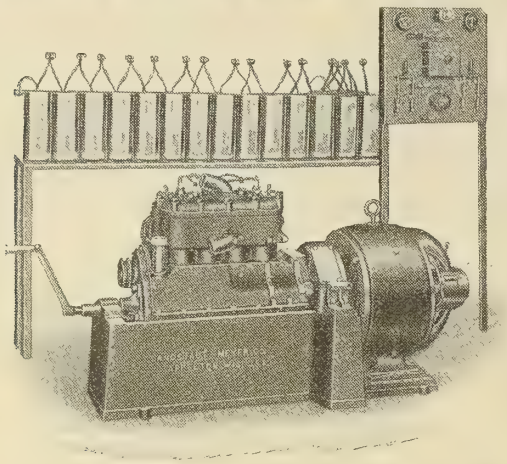
The *California* was built in England twenty-one years ago.

(*Photograph from Underwood & Underwood, New York*)

German Destroyer *V*-69 Lying at Anchor in the Harbor of Ymuiden, Holland, near Amsterdam, After Recent Battle with British Naval Forces

Generating Unit for Marine Use

The illustration shows a gasoline-driven (petrol), direct-connected electric generating unit which is being manufactured by the Langstadt Meyer Company of Appleton, Wis., in two models of 4-kilowatt and 5-kilowatt capacity each, to furnish electric light and power for yachts, vessels, patrol boats and life-saving station service. They are entirely self-contained, quiet and economical in operation and compact. Two of the main features of the design are slow speed, which means long life and low maintenance cost, and a close governor regulation irrespective of the number of lights in operation. The small units will furnish the necessary current for a 19-inch



Gasoline (Petrol)-Driven Electric Generating Unit

8,000-candlepower searchlight suitable for submarine patrol boats or ships, and the larger machine will handle a 24-inch 10,000-candlepower projector.

The portable unit is especially adapted for furnishing current for searchlights used by life-saving stations. The light may be mounted on the shore to aid life-saving crews in the work of shooting lines to the wreck, or in taking men from a stranded vessel. The machine is entirely self-contained, and therefore may be transported on a light truck or hand-drawn vehicle, and may be operated without being removed.

As the operation of these machines, when installed in a boat, is independent of the main engine, all the available power is utilized in the propelling mechanism. Storage batteries are not necessary, but may be installed if desired.

The manufacturers are anxious to get in touch with capable dealers and shipowners needing such equipment. They are ready to furnish detailed description of those units, together with photographs and test data. This information may be obtained by addressing their Appleton office.

D. C. Motors of the Lower Horsepowers

To meet the increasing demand for direct-current motors of the smaller horsepowers for direct connection and drive of all kinds of industrial machinery, machine tools and the many motor applications requiring a low-power, compact motor, the C. & C. Electric & Manufacturing Company, of Garwood, N. J., has developed a new line of type IB bi-polar motors in ratings up to 10 horsepower, in either the shunt or

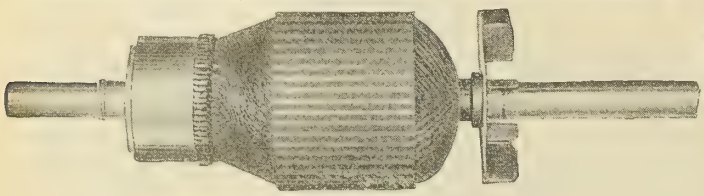


Fig. 1.—The I. B. Armature

compound wound with interpoles. For driving machine tools and other industrial machinery the characteristics of the shunt-wound motors are the most desirable. It is essentially a constant speed machine, having close speed regulation from no load to full load, and is recommended for all purposes where the torque required for starting and accelerating does not greatly exceed full-load torque. The compound-wound motor is desirable for drives where the starting torque is much heavier than the full-load torque. This motor starts at a much heavier load than the shunt-wound motor, and any degree of compounding can be furnished to meet conditions. Adjustment of the speed is obtained in both cases by either armature or field control.

The armatures are of standard design with laminated core.

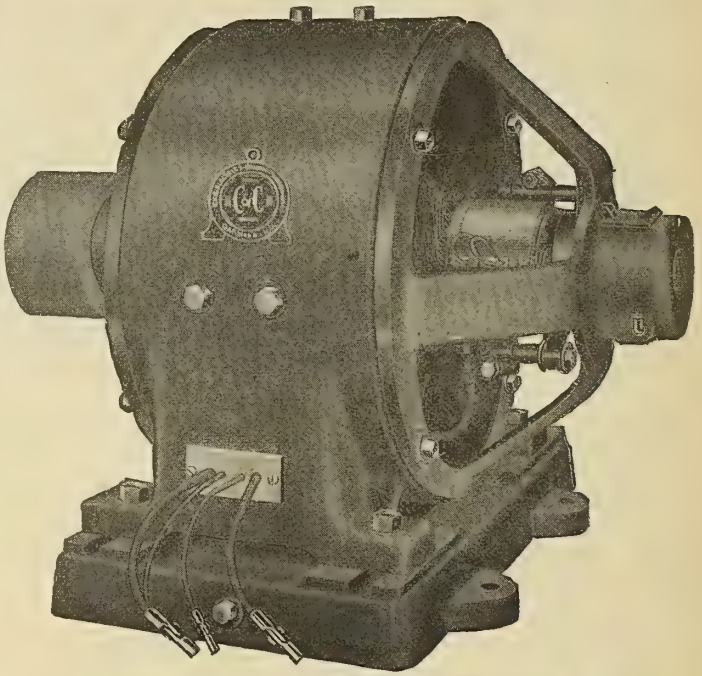


Fig. 2.—C. & C. Type I. B. Motor, with Universal Base

An air agitating fan is placed on the pulley side of the shaft, next to the armature winding, to furnish the very high degree of ventilation and cooling so necessary in motors of the smaller compact frame and guarantees servere service and heavy overloads. In continuous operation for long periods

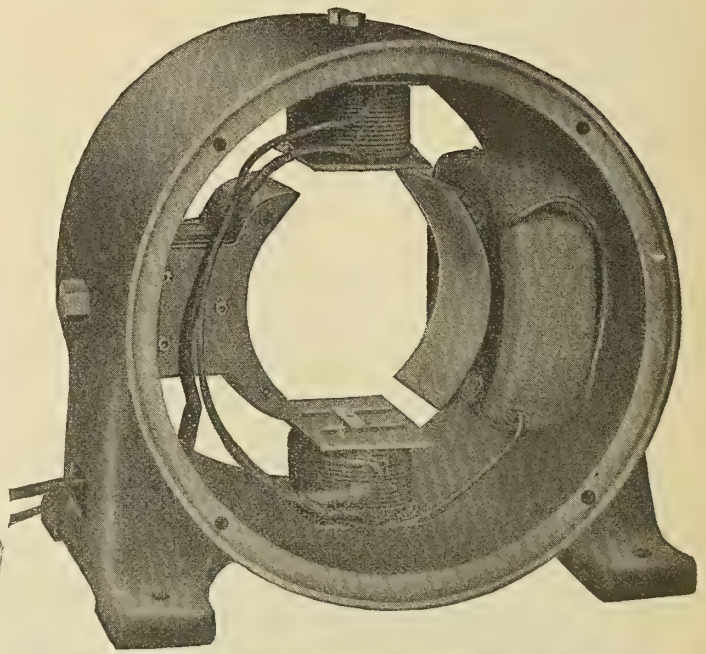


Fig. 3.—Main Frame, with Field and Commutating Poles

the motors run cool and without attention. The interpoles insure sparkless commutation through the full range of load without changing the brush position.

The new line of motors is furnished in the open type, or with perforated or totally enclosing covers for protection against dust, metal chips, dampness, etc. For belt drive the motors can be furnished with either a universal slide rail base or a belt tightener idler pulley.

S. S. *D. G. Scofeld*, Built in 1916 by the Union Iron Works, San Francisco, for the Standard Oil Company of California, at the Builders' Fitting Out Dock

PERSONAL

H. McL. Harding, terminal engineer, New York city, has been appointed consulting terminal expert in connection with the building of the chain of terminals to be located at the various cities along the New York State barge canal. Mr. Harding is president of the Society of Terminal Engineers recently organized in New York.

Prof. R. C. Carpenter, professor of experimental engineering, Sibley College, Cornell University, will sever his active connection with Cornell University at the end of the present college year, having reached the age of retirement.

B. F. Cresson, Jr., has resigned as chief engineer of the New Jersey State Board of Commerce and Navigation to become consulting engineer, with offices at 30 Church street, New York City. For a number of years Mr. Cresson was first deputy commissioner of the Department of Docks and Ferries of the city of New York. He will specialize in harbor works, piers, docks, bulkheads and reports on harbor improvement.

John C. Payne, of Trenton, N. J., has been appointed chief engineer of the New Jersey Board of Commerce and Navigation, vice B. F. Cresson, Jr., resigned.

Paul P. Whitham, consulting engineer, Seattle, Wash., designer of the municipal piers at Seattle, has been selected by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, to make a study of the existing and proposed port and transportation facilities of Russia and the Far East. Mr. Whitham will be abroad about two years, and his itinerary will include Russia, China, Japan, Philippines, France-China, Federated Malay States, East Indies, Burma, India and Australia.

OBITUARY

John S. Hyde, since 1905 president and sole owner of the Bath Iron Works, Bath, Me., died suddenly on March 17 in St. Augustine, Fla., aged 50 years.

Henderson Weir, secretary of the Harlan & Hollingsworth Corporation, Wilmington, Del., died suddenly on March 4. He had been connected with the company for about twenty-one years.

Capt. George A. White, assistant general manager of the Hudson River Day Line, New York, and well known throughout the country among steamboat men, died in Asheville, N. C., on March 8, aged 61.

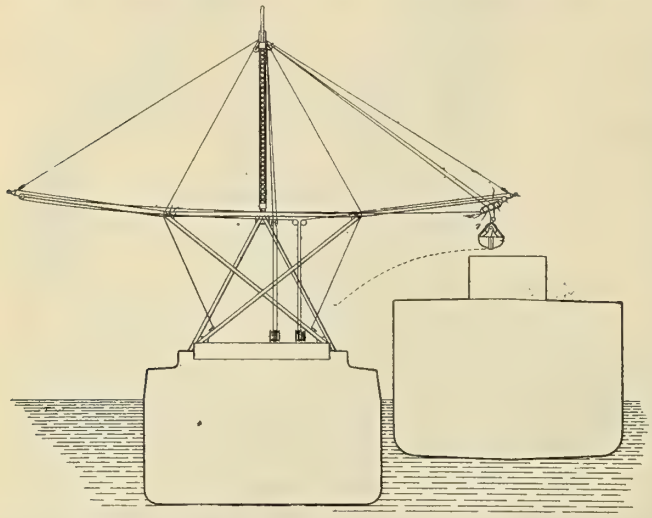
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,193,587. LOAD TRANSFER APPARATUS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

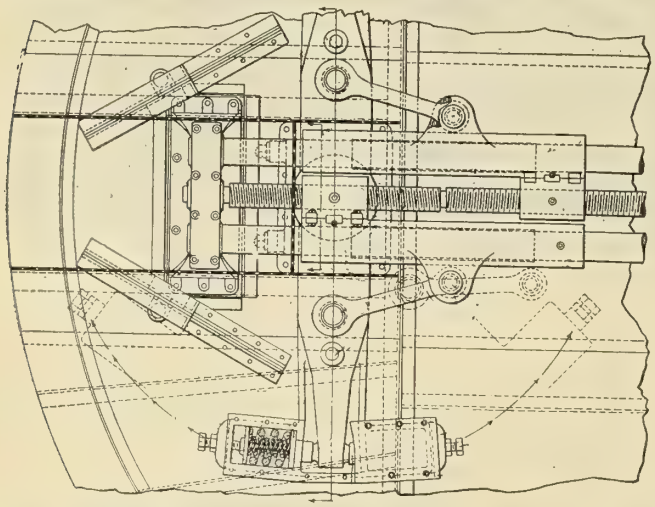
Claim 1.—A load transfer apparaus comprising a mastlike structure, two booms pivotally mounted on said structure, means whereby the



pivots of said booms may be adjusted transversely of said structure, and a rope system supported at its ends by the two booms. Twenty-nine claims.

1,205,169. STEERING APPARATUS FOR SHIPS. WILLIAM A. DOBSON, OF PHILADELPHIA, PA.

Claim 1.—A steering apparatus for ships, which comprises in combination:—a hull,—a rudder,—a rudder-stock,—a cross-head fixed upon said rudder-stock,—a floating cross-head rotative upon said rudder stock,



—shock-absorbing mechanism interposed between and connective of both cross-heads at their outer extremities,—and steering means for imparting rotative movement to the floating cross-head. Eleven claims.

1,205,638. SHIP-BRAKE. JOHN H. HYDE, OF TACOMA, WASHINGTON.

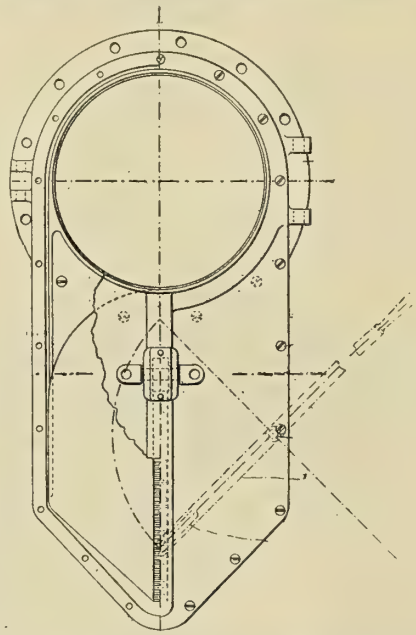
Claim 4.—The combination with a ship of a plurality of brakes therefor, cables attached to said brakes, and means for hauling in said cables

comprising a steam cylinder having a piston therein, an air cylinder, and a piston in said air cylinder connected to said steam piston, said means being so arranged that air is compressed on the outstroke of the brakes whereby the air piston assists the steam piston in drawing in the brakes. Five claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

10,895/15. "IMPROVEMENTS RELATING TO SHIPS' LIGHTS." E. BENVENUTI, OF CAPE DELL UFFICIO TECNICO DELLA NAVIGAZIONE GENERALE ITALIANA, GENOA, ITALY, ENGINEER.

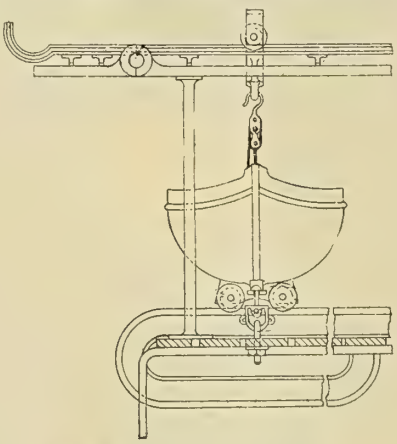
This invention comprises improvements relating to ships' lights, such as port openings and side lights, and it also concerns overboard discharge apertures for ships. The invention has for its object to provide in



addition to the usual lights or sashes, improved means for closing the portholes and other apertures, and also to provide, in some cases, means whereby a number of such closing means may be controlled from a central station, such as the ship's bridge, for example.

11,743/15. MEANS FOR SUPPORTING AND LAUNCHING SHIPS' LIFE BOATS. A. R. HINMAN, OF 9, SIEBERT ROAD, WESTCOMBE PARK, LONDON, S. E.

My invention relates to means for supporting ships' life boats upon movable carriages adapted to travel across the boat deck from side to side, and to means for launching the boat from these carriages from either side of the vessel. To handle and launch life boats, levers are turned so as to release bolts from brackets on each end of the life boat, which is then run along rails until it reaches a position in which it re-



mains suspended from the end of overhead rails, the roller of the bracket engaging in the depression in these end portions of the rail so as to prevent the displacement of the brackets and the suspended life boat, through the rolling of the vessel. The boats, which have been previously manned and filled when secured in position on the deck, are at once lowered away as rapidly as possible, and as soon as they have reached the water and the tackle has been detached, the brackets are removed from the ends of the overhead rails and are thrown aside. The next boat is then brought up and lowered away in the same manner, and as each boat is run out and launched, the supporting carriages on the rails run over the ends of these rails and down on to the turn-in ends in the compartment underneath the boat deck, in which they will be retained for future use when required. In this manner any desired number of boats may be mounted and supported on the boat deck in a position and manner ready for immediate use without unduly obstructing the deck. These boats may be rapidly filled and launched in succession from either or both sides of the vessel, in accordance with the weather conditions.

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LIBRARY MAY 4 1917 PATENT OFFICE

Proclamation By the President to the People

The White House, April 15, 1917.

My Fellow-Countrymen:

THE ENTRANCE of our own beloved country into the grim and terrible war for democracy and human rights which has shaken the world creates so many problems of national life and action which call for immediate consideration and settlement that I hope you will permit me to address to you a few words of earnest counsel and appeal with regard to them.

We are rapidly putting our navy upon an effective war footing and are about to create and equip a great army, but these are the simplest parts of the great task to which we have addressed ourselves. There is not a single selfish element, so far as I can see, in the cause we are fighting for. We are fighting for what we believe and wish to be the rights of mankind and for the future peace and security of the world. To do this great thing worthily and successfully we must devote ourselves to the service without regard to profit or material advantage and with an energy and intelligence that will rise to the level of the enterprise itself. We must realize to the full how great the task is and how many things, how many kinds and elements of capacity and service and self-sacrifice it involves.

These, then, are the things we must do, and do well, besides fighting—the things without which mere fighting would be fruitless:

We must supply abundant food for ourselves and for our armies and our seamen, not only, but also for a large part of the nations with whom we have now made common cause, in whose support and by whose sides we shall be fighting.

We must supply ships by the hundreds out of our shipyards to carry to the other side of the sea, submarines or no submarines, what will every day be needed there, and abundant materials out of our fields and our mines and our factories with which not only to clothe and equip our own forces on land and sea, but also to clothe and support our people, for whom the gallant fellows under arms can no longer work; to help clothe and equip the armies with which we are co-operating in Europe, and to keep the looms and manufactories there in raw material; coal to keep the fires going in ships at sea and in the furnaces of hundreds of factories across the sea; steel out of which to make arms and ammunition both here and there; rails for worn-out railways back of the fighting fronts; locomotives and rolling stock to take the place of those every day going to pieces; mules, horses, cattle for labor and for military service; everything with which the people of England and France and Italy and Russia have usually supplied themselves, but cannot now afford the men, the materials, or the machinery to make.

It is evident to every thinking man that our industries, on the farms, in the shipyards, in the mines, in the factories, must be made more prolific and more efficient than ever, and that they must be more economically managed and better adapted to the particular requirements of our task than they have been; and what I want to say is that the men and the women who devote their thought and their energy to these things will be serving the country and conducting the fight for peace and freedom just as truly and just as effectively as the men on the battlefield or in the trenches. The industrial forces of the country, men and women alike, will be a great national, a great international service army—a notable and honored host engaged in the service of the nation and the world, the efficient friends and saviors of free men everywhere. Thousands, nay, hundreds of thousands, of men otherwise liable to military service will of

right and necessity be excused from that service and assigned to the fundamental sustaining work of the fields and factories and mines, and they will be as much a part of the great patriotic forces of the nation as the men under fire.

I take the liberty, therefore, of addressing this word to the farmers of the country and to all who work on the farms: The supreme need of our own nation and of the nations with which we are co-operating is an abundance of supplies, and especially of foodstuffs. The importance of an adequate food supply, especially for the present year, is superlative. Without abundant food alike for the armies and the peoples now at war, the whole great enterprise upon which we have embarked will break down and fail. The world's food reserves are low. Not only during the present emergency, but for some time after peace shall have come, both our own people and a large proportion of the people of Europe must rely upon the harvests in America.

Upon the farmers of this country, therefore, in large measure rests the fate of the war and the fate of the nations. May the nation not count upon them to omit no step that will increase the production of their land or that will bring about the most effectual co-operation in the sale and distribution of their products? The time is short. It is of the most imperative importance that everything possible be done, and done immediately, to make sure of large harvests. I call upon young men and old alike and upon the able-bodied boys of the land to accept and act upon this duty—to turn in hosts to the farms and make certain that no pains and no labor is lacking in this great matter.

I particularly appeal to the farmers of the South to plant abundant foodstuffs, as well as cotton. They can show their patriotism in no better or more convincing way than by resisting the great temptation of the present price of cotton and helping, helping upon a great scale, to feed the nation and the peoples everywhere who are fighting for their liberties and for our own. The variety of their crops will be the visible measure of their comprehension of their national duty.

The government of the United States and the governments of the several States stand ready to co-operate. They will do everything possible to assist farmers in securing an adequate supply of seed, an adequate force of laborers when they are most needed, at harvest time, and the means of expediting shipments of fertilizers and farm machinery, as well as of the crops themselves when harvested. The course of trade shall be as unhampered as it is possible to make it, and there shall be no unwarranted manipulation of the nation's food supply by those who handle it on its way to the consumer. This is our opportunity to demonstrate the efficiency of a great democracy, and we shall not fall short of it!

This let me say to the middlemen of every sort, whether they are handling our foodstuffs or our raw materials of manufacture or the products of our mills and factories: The eyes of the country will be especially upon you. This is your opportunity for signal service, efficient and disinterested. The country expects you, as it expects all others, to forego unusual profits, to organize and expedite shipments of supplies of every kind, but especially of food, with an eye to the service you are rendering and in the spirit of those who enlist in the ranks, for their people, not for themselves. I shall confidently expect you to deserve and win the confidence of people of every sort and station.

To the men who run the railways of the country, whether they be managers or operative employees, let me say that the railways are the arteries of the nation's life and that upon them rests the immense responsibility of seeing to it that those arteries suffer no obstruction of any kind, no inefficiency or slackened power. **To the merchant let me suggest the motto, "Small profits and quick service," and to the shipbuilder the thought that the life of the war depends upon him. The food and the war supplies must be carried across the seas, no matter how many ships are sent to the bottom. The places of those that go down must be supplied, and supplied at once.** To the miner let me say that he stands where the farmer does: the work of the world waits on him. If he slackens or fails, armies and statesmen are helpless. He also is enlisted in the great Service Army. The manufacturer does not need to be told, I hope, that the nation looks to him to speed and perfect every process; and I want only to remind his employees that their service is absolutely indispensable and is counted on by every man who loves the country and its liberties.

Let me suggest, also, that every one who creates or cultivates a garden, helps, and helps greatly, to solve the problem of the feeding of the nations; and that every housewife who practices strict economy puts herself in the ranks of those who serve the nation. This is the time for America to correct her unpardonable fault of wastefulness and extravagance. Let every man and every woman assume the duty of careful, provident use and expenditure as a public duty, as a dictate of patriotism, which no one can now expect ever to be excused or forgiven for ignoring.

In the hope that this statement of the needs of the nation and of the world in this hour of supreme crisis may stimulate those to whom it comes and remind all who need reminder of the solemn duties of a time such as the world has never seen before, I beg that all editors and publishers everywhere will give as prominent publication and as wide circulation as possible to this appeal. I venture to suggest, also, to all advertising agencies that they would perhaps render a very substantial and timely service to the country if they would give it widespread repetition. And I hope that clergymen will not think the theme of it an unworthy or inappropriate subject of comment and homily from their pulpits.

The supreme test of the nation has come. We must all speak, act, and serve together!

WOODROW WILSON.

The Editorial Conference of the New York Business Publishers Association, Inc., at a luncheon on April 16, passed the following resolution:

"Resolved, The members of the Editorial Conference of the class journals of New York City here assembled are glad to respond to President Wilson's appeal in his proclamation of April 15, and will do all in their power to lead and insure the industries they represent to render that patriotic service to the nation which the President has requested."

During the same week, 277 class journals of the United States offered to give to the government editorial co-operation and free advertising space to support government activities in connection with the war. It is proposed by these journals to keep closely in touch with the government in its work and wherever matter of importance develops, which the class journals should lay before their readers, to take measures for its general distribution to them.

A Call to Service

WITH the entrance of the United States into the world-wide conflict for the preservation of free government and the liberties of mankind, the people of the nation are given the opportunity and privilege to demonstrate that the fundamental principles of democracy, justice and humanity on which the nation was founded and to the preservation of which it owes its growth, must be respected and preserved throughout the civilized world. To accomplish this, the nation's resources in men and wealth must be given without reservation.

To the shipbuilding and shipping industries of the nation the "Proclamation by the President to the People," issued from the White House on April 15, comes as a call for definite service. The need is clearly expressed. "We must supply ships by the hundreds out of our shipyards to carry to the other side of the sea, submarines or no submarines, what will every day be needed there . . . to the shipbuilder, let me suggest the thought that the life of the war depends upon him."

For the nation to utilize its resources in this great conflict the first requisite is overseas transportation. Not only is the need for ships urgent at the present moment, but it will continually become more urgent as the months pass by. To furnish ships we must have not only vastly increased shipbuilding facilities, but also materials, trained shipbuilders, skilled artisans and, what is of equal importance, men to man the ships.

If the vast resources of the mines, forests, workshops and seafaring industries of the country are to be effectively applied to this great task of upbuilding the world's merchant marine, let every man who, by training or experience, is qualified to aid in the development of the maritime resources of the country heed this call and offer his services at once.

Emergency Fleet of Wooden Cargo Ships

OVER 1,000,000 tons of merchant shipping was destroyed by German submarines and mines during the months of February and March this year, and the rate of destruction during April has probably increased. At least considerably more than 5,000,000 tons of merchant shipping has been destroyed by the Central Powers since the war started, and there is every indication that the undersea warfare will be prosecuted by them with increasing vigor during the coming summer months.

To offset these losses there will be a general speeding up of merchant ship construction in the United States, a rapid overhaul of the 600,000 tons of German shipping seized by the Government, and probably a temporary suspension of work on naval contracts which cannot be completed within three years, making available facilities for building at least 500,000 tons of merchant ships in addition to the large volume of business that is now in hand in the steel shipyards on the coasts and Great Lakes.

Together with the extraordinary boom in steel shipbuilding, however, there has also been a remarkable revival in wooden shipbuilding. Over forty wooden shipbuilding yards are now building ocean-going vessels of various types, and the plans of the United States Shipping Board to build an emergency fleet of hundreds of medium-sized cargo boats to aid in carrying foodstuffs, munitions and supplies through the war zone to the Allies means the immediate expansion of the wooden shipbuilding industry.

To build this fleet the United States Shipping Board has organized the United States Shipping Board Emergency Corporation, capitalized at $50,000,000 (£10,250,000), to purchase wooden ships which will be chartered and leased to citizens of the United States to be operated by them in foreign trade. This project has been indorsed by the President, and at his request Major General George W. Goethals, U. S. A., retired, builder of the Panama Canal, has taken charge of the enterprise.

Before entering upon this project the United States Shipping Board made a thorough investigation of the lumber interests and of the smaller machine and boiler shops and steel plants throughout the country to determine the feasibility of securing the necessary materials and propelling and auxiliary machinery for these vessels. As a result, they were able to advise the President and the Council of National Defence that under proper organization it would be probable, without disturbing the steel making or the steel shipbuilding industries, to produce monthly in the neighborhood of 200,000 tons of such shipping each month, beginning at about seven or eight months after the work was undertaken.

The plans provide for the building of vessels of about 3,500 tons deadweight carrying capacity and of about 10 knots sea speed, for which propelling machinery of about 1,500 horsepower will be required for each vessel. It is considered within the range of possibility to produce a fleet of 800 to 1,000 ships of this type within about eighteen months, and that this, combined with the output of steel merchant vessels produced in that time, will exceed or keep pace with the highest rate of submarine destruction, and thus make the German submarine blockade ineffectual.

In carrying out this undertaking it is unlikely that any difficulty will be found in securing the necessary timber, although the supply of seasoned lumber, which would be preferable, will be insufficient, but it is obvious that the resources of the engine, boiler and machinery builders, as well as of the labor market of wood-workers, will be severely taxed.

Plans for one class of wooden cargo boats which have been accepted by the United States Shipping Board, and which have received the highest rating ever granted for wooden vessels by the American Bureau of Shipping, are printed elsewhere in this issue. This design, by William T. Donnelly, of New York, presents a new departure in wooden ship construction in that the principles evolved in the development of steel shipbuilding are directly applied to wooden construction, resulting in a ship far superior in strength and carrying capacity to the type of ship formerly built of wood. The construction is such that practically all parts are standardized, so that the material as received from the mills can be assembled into the ship with a minimum of fabrication at the yard. As undoubtedly a large number of ships for the emergency fleet will be built in accordance with these designs, a careful study of the details as set forth in this issue will be desirable.

As speed of construction is a first requisite in the building of this fleet, all shipbuilders and engine and machinery manufacturers who have facilities adaptable to this work should immediately place their plants at the disposal of the Shipping Board, whose headquarters are in the Munsey building, Washington, D. C. Contracts for this work will be placed by the Emergency fleet corporation and its agents.

LETTERS TO THE EDITOR

Standardizing Shipbuilding

Standard construction is not a new idea. It is the most striven-for pinnacle of successful manufacture, from needles to engines, and it has not been applied to shipbuilding mainly because there has not been a market for wholesale production.

Retardation in American shipyards has not been due to the want of progressiveness on the part of their managers and owners, but rather to the slackness of demand. The unusual condition of a modern war has developed new shipbuilding opportunity for America and at last there is an incentive for shipbuilding.

Germany and England are reported to have been building standardized vessels for some time in the manner for which some of the American yards are now aiming and have found it the ideal method of quickening construction. The demand for ships was not great enough before this war to require the method to be practiced, but necessity is always the mother of a new contrivance.

The trouble in American yards is that each yard is attempting to standardize its own ship, each yard on different lines. If any degree of permanence is to be established after the war in American shipbuilding it will have to be done through a design of ship fathered by the Government. There would obviously be difficulties if the matter were left to private enterprises in getting owners to agree on a standard specification which would not exist in the case of a Government committee.

What more appropriate organization to develop a real standard ship than the new Federal Shipping Board? It is reported that ample authority will be given to this board for building up and regulating American shipping in the world's trade; then upon its success will rest in a large measure the future expansion of the American merchant marine. But the earnest co-operation and support of all shipping interest will be necessary thereto.

The type of vessel more nearly approaching the needs of all in general seems to be a single-deck steamer designed for purely cargo-carrying purposes, with a depth of about 31 or 32 feet and a deadweight carrying capacity of about 8,000 tons, having virtually no superstructure, and with nothing in its structure that is not absolutely essential for efficient handling and for carrying of general or bulk cargoes.

The fact that it is to be standard in design would facilitate the procuring of material as well as increasing the rapidity of building. With plentiful supplies of material and sufficient skilled labor it is estimated that vessels of this type could be completed in from four to six mouths.

At the present time the hull of a vessel can be built more speedily than the engine and boilers that go into it. It would be practicable to expedite construction of the engine by increased sub-divisions and standardization. Assuming the adoption of a reciprocating engine of a design that has proven entirely trustworthy and could be turned out by any reputable marine engineering plant, the arrangements could be such that any particular set of engines need not be reserved for any particular hull. If a hull were ready in one yard and a set of engines ready somewhere else they may be brought together to form one ship, so that the delays caused by hulls being in advance of the engines or engines ahead of hulls could to a large extent be avoided.

In the development of the new method it is well to consider the enormous stride made of late in the improvement in the machinery for fabricating ship structural parts, especially the multiple punch and spacing table. By co-operating with the mills, once a standard has been set, the structural shapes and plates instead of being ordered from the mill in the raw form could be ordered to their particular standard and fabricated right at the source of creation and shipped ready to erect, making the yard in reality the erecting or field station.

If the "new" idea and the co-operative enterprise in shipbuilding in this country are to be encouraged, this nation must learn, not how to build ships (there never has been a question that the United States can build ships in competition with the world, as well as in other lines of manufacture), but how to operate them in fair competition with other nations under normal conditions of the sea. In this direction the nation's talents have not been put to the test, because the artificial requirements of law and restrictions have made it more difficult for Americans to operate ships.

T. L. COHEE,
Quarterman Shipfitter, in charge new contruction,
League Island Navy Yard.

Philadelphia, Pa.

Screw Propeller Designing—The Guess vs. the Scientific Method

The fact that many engineers use a great deal of guesswork in connection with propeller designing is well known and is admitted to be so by many of said individuals. Taking this fact into consideration, it seems that such an important part of the vessel as the screw propeller should receive most careful study and attention, in order to produce the very highest efficiency and eliminate all doubt and worry which usually exist where the guess method is predominant. It is true that a fairly good propeller can be designed in many cases by the comparative method, but where the deviations from this method are great, the comparative method is just as good as the old guess method, and as a matter of fact the guess method would be used to a great extent in such a case.

With the above facts staring every naval architect and marine engineer in the face, there are still those who believe that they can design a propeller by the guess method, or comparative method, which will produce the required results, and in many cases they can produce such designs when they have a certain engine power available and a certain form of hull given which compares very favorably with a similar hull for which they have designed propellers before, but they do not stop to realize that a propeller could be designed by proper authorities which would not require as much horsepower and yet would give the same results or better. This leads back to the fact that every engineer and naval architect should keep foremost in his mind that "the propeller should be the starting point for the design of marine propulsive machinery," for it is only after this element is correct that the design of boilers and engines will follow along in logically efficient lines.

The many failures which have existed in connection with propulsive problems have been due to the ignorance of the propeller designer in not realizing the importance of his work, and it is a known fact that approximately 60 percent of the vessels now in use could be made more efficient by a proper design of screw propeller. This fact may seem rather alarming, but it has been found to be true by modern authorities and those who have analyzed many of the propellers designed up to a few years ago. Such failures are sometimes never known, simply because the vessel attains her contract speed, and, furthermore, because an efficient trial trip was never run. This latter

fact is in most cases true in connection with the wooden motorships, auxiliary schooners, yachts, etc.

In summing up the above as a whole, the question as to "who can design propellers of the highest efficiency" will no doubt arise. The answer to this is very simple, as there are several individuals and one company which make a specialty of the estimation of power for propulsion of vessels and the designing of screw propellers. The services of the above can be secured very readily and at a very moderate cost, and it would be advisable for all those who are interested in eliminating waste of power, time and money to get in touch with said parties and profit by their experience, knowledge and equipment.

The design of a proper propeller, as every engineer knows, is a difficult task, and requires experience, knowledge and equipment; without these assets it is almost impossible to reach the high propulsive efficiency sought for by most engineers and attained by so few.

The above is not meant as a reflection upon the ability or knowledge of the average marine engineer, as the designing of a screw propeller is a very scientific study and requires patience, knowledge and experience; therefore, it is readily seen that unless an individual possesses these assets, he is really not qualified to be entrusted with propulsive problems. Furthermore, the average engineer does not have the time to specialize upon this subject, due to the many other branches of engineering which he is compelled to know. Realizing these facts, it is readily seen that money and doubt would be saved by referring this matter to experts, of which there are a few in this country, as stated before.

Philadelphia, Pa. RAYMOND E. LOVEKIN.

Lloyd George's Speech and Its Relation to Motorship Development

In offering apologies for the late date of discussion of the Prime Minister's speech I must offer as an excuse the great distance that separates America and Great Britain, and the abnormal time that it now takes for mails to twice cross the Atlantic Ocean. I want to draw attention to a part of Mr. Lloyd George's speech, the full purport of which nobody else seems to have grasped:

"Have you been watching what is going on? Before the war we had a good many shortcomings in our business, our commerce, our industry. The war is settling them all right in the most marvelous way. You ask a great business man like my friend, Lord Pirrie, what is going on in those great factories throughout Great Britain and Ireland. Old machinery is scrapped; the newest, the best and the latest is set up; slipshod and wasteful methods are scrapped and hampering customs are discontinued. Millions are brought into the labor market to help to produce who were before purely consumers." (Extract from recent Guildhall speech by Mr. Lloyd George.)

It does not need very close scrutiny to obtain an understanding of what the above words from the lips of Lloyd George must mean to the development and progress of the motorship in the near future. Before the war the number of large Diesel motorships built or building in the British Isles almost could have been counted on the fingers of both hands, for at that time the true worth of the motorship was not fully appreciated by shipowners outside of the European Continent.

War, however terrible it may be, is a wonderful developer, and it has enabled Britain to grasp the full value of the internal combustion engine and its uses are multitudinous. As soon as peace comes I believe Great Britain will make strong endeavors to become the leading Diesel engine and motorship constructor of the world, and in this respect the recent significant words of Sir James Mills and Mr. James A. Milton also may be put forward as a reminder of what will be done by British shipbuilders and engineers. Hardly anything is being done in the United States to meet these probable steps. This is due to two reasons, namely, the apparent unwillingness of American shipowners to "risk" a small portion of the enormous profits now being made, and to the apparent unwillingness of American shipbuilders to undertake the construction of their first Diesel motorships without being assured of making a good profit. They should look at the situation from a different aspect.

It is most unpleasant to display the actions of other countries as a paragon, but in this particular case the striking difference in the attitude of shipowners and shipbuilders, such as the Danes and Norwegians, makes it a necessity. The present spirit in America is not the one that will produce a big merchant navy, and a great mercantile fleet is desired.

In the early days European shipowners placed orders for big motorships, fully aware that such would cost them dearly until the heavy oil engine was perfected, and shipbuilders undertook the constructions, knowing perfectly well that experimenting and developing would cost them far more than the money for such vessels. Both knew that their rewards would come when they had placed several motorships in service, and were content to wait accordingly. Making too much money often makes us selfish. The unselfish position thus taken in Europe has been the means of producing several makes of successful and perfectly reliable sea-going type Diesel oil engines of sufficient power to propel large ocean freighters.

What has America to show?

Nothing!—absolutely nothing tangible!

If American shipbuilders, or shipowners, now desire high-powered marine engines, they will have to buy the experience or the engines from Europe, or else spend years and fortunes in development work. The war, of course, has stopped the allied countries from producing much in the way of motorships to date, otherwise England would have made up for lost time; but I believe operations on a large scale already have been started in Great Britain.

In the extract of Lloyd George's speech it will be noticed that he refers to that great and far-seeing business man, shipowner and shipbuilder, Lord Pirrie. It is Lord Pirrie who has shown in a most emphatic and substantial manner that he is one of the strongest believers in the immediate future of the mercantile Diesel-driven motorship. At one of his great shipyards, where the world's mightiest merchant steamships were built, four big motorships—some reports say seven—are about to be laid down, and four of these will be the largest Diesel-driven vessels in the world. He expresses his confidence, not by building one great vessel, mark you, but by ordering at least four together—the others are for the Elder Dempster Company.

This confidence is based on experience, not on boldness alone, because one of the great shipping interests controlled by him has sold all its steamers and replaced them with Diesel motorships. Let us give him credit for knowing the shipping business from A to Z.

Furthermore, it is through Lord Pirrie interests that a small European steamship building yard has become one of the most important mercantile motor shipyards in the world. *This yard now has its capacity booked for six years ahead entirely with Diesel motorships. No steamship yard in the world is in such a fortunate position.*

(*Concluded on page 212*)

Problem of the Wooden Cargo Ship

Description and Calculations Relative to Construction of 5,500-Ton Deadweight Carrying Capacity Cargo Vessel

BY WILLIAM T. DONNELLY *

THE plans and information submitted herewith relative to a wooden ship of dimensions and carrying power much beyond anything hitherto constructed are the result of many years given to the study and investigation of this problem, and are not to be considered in any sense a war measure. In fact, the plans as here presented, together with the calculations, were almost, if not quite, complete before the present agitation for wooden ships was brought about by unrestricted submarine warfare.

The writer's attention was directed to the problem of the wooden ships by investigations and developments in the application of wood to floating dry docks, which in the last twenty years has resulted in the building of these structures up to a carrying power of 20,000 tons.

* Naval architect, 17 Battery Place, New York City.

The problem as here presented is believed to be a thoroughly scientific and practical solution of the use of wood as an engineering material for ship construction, and the plans as here presented have received very careful review and criticism by engineers of the highest standing. The fact that they have been passed by the American Bureau of Shipping for their highest rating would seem to entitle them to every consideration. The writer, however, presents them entirely upon their own merits and invites criticisms from all parties at all interested.

Longitudinal Strength

The vessel shown in the plans is 350 feet long between perpendiculars, 50 feet beam and 30 feet molded depth, with a deadweight cargo-carrying capacity of 5,500 tons.

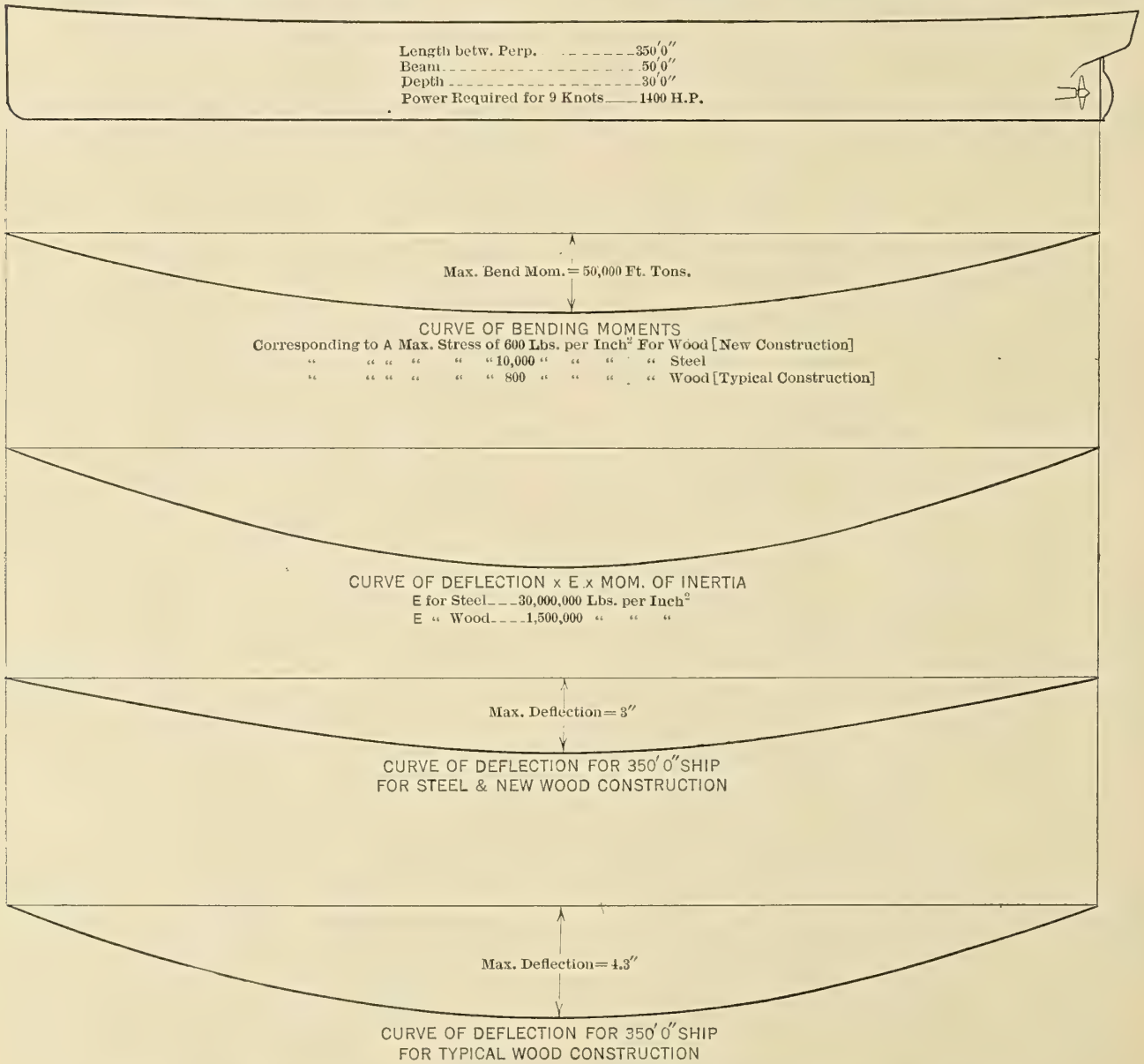

Fig. 1.—Longitudinal Deflection Diagrams, Showing Comparative Longitudinal Strength and Rigidity of Steel and Wooden Hulls

For the longitudinal strength and deflection, see Figs. 1-4. In these figures will be seen a typical section of a steel double bottom ship of similar dimensions to the wooden hull under consideration, and the weight of plates assigned to this midship section has been taken from Lloyds rules for scantlings, and the center of gravity, moment of inertia, and other mathematical functions are set forth with reference to each hull, and also with reference to the typical ship construction increased to the dimensions under consideration.

On the section of the proposed new hull there is shown the thickness of planking and timbers to be used, together with indication showing where edgebolting of timbers is required—also the arrangement of a double wooden bottom carried up around the bilge, and longitudinal division of double bottom to stiffen it locally.

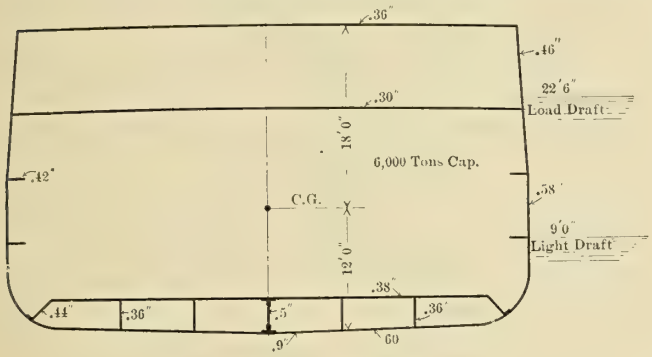

Fig. 2.—Section of Steel Hull

Working Stress.—10,000 pounds per inch.^{2}
Moment of Inertia.—25,000,000 inch.^{4}
Section Modulus.—116,000 inch.^{3}
Resistance Mom.—50,000 foot-tons.

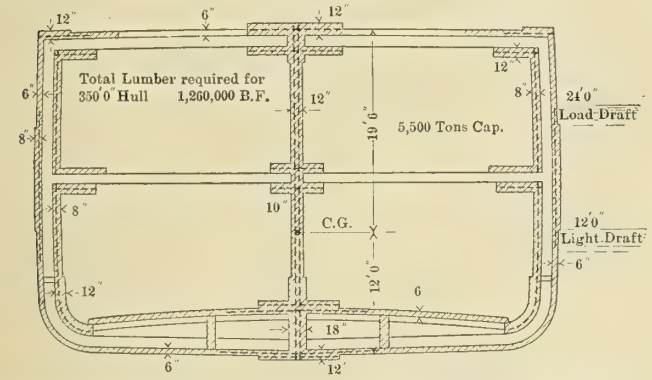

Fig. 3.—New Construction—Section of Wooden Hull of Equal Strength and Stiffness as Same Size Steel Hull

Moment of Inertia.—500,000,000 inch.^{4}
Working Stress.—600 pounds per inch.^{2}
Section Modulus.—2,135,000 inch.^{3}
Resistance Mom.—50.000 foot-tons.
Effective Area of Section.—200 square feet

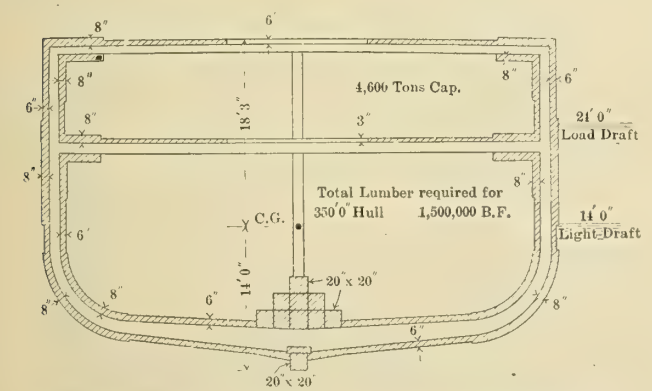

Fig. 4.—Section of Wooden Hull—Typical Construction

Moment of Inertia.—350,000,000 inch.^{4}
Section Modulus.—1,600,000 inch.^{3}
Resistance Mom.—37,000 foot-tons.
Effective Area of Section.—175 square feet.

It will be understood that every eighth bottom truss is to be filled in, making it a transverse bulkhead within the double bottom.

In Fig. 1 are shown the longitudinal deflection diagrams, giving information relative to the comparative longitudinal strength and rigidity of the hulls. In working these out I have used the modulus of elasticity for steel of 30,000,000, and for wood 1,500,000 pounds.

For the steel hull the deflection was worked out to correspond with a maximum stress of 10,000 pounds per square inch, upon the material of the midship section, and was found to be 3 inches; and then a similar calculation was applied to the midship section of the wooden hull to determine the stress per square inch for the same deflection, and this was found to be 600 pounds.

Factor of Safety of Wooden Ship

In comparing these results, it should be noted that a working stress of 10,000 pounds per square inch for steel compared with an ultimate strength of 60,000 pounds, gives a factor of safety of 6, while a working stress of 600 pounds per square inch applied to wood as compared with an ultimate strength of from 8,000 to 10,000 pounds gives a factor of safety of something more than 12. A further analysis of this result would be to state, that to obtain the corresponding rigidity in a wooden structure to a similar one of steel, it is only necessary to use a working fiber stress less in proportion to the ultimate strength, but this statement should be qualified by the possibility of using the engineering device more fully explained later on—that is, of so organizing the structure as to put the component parts under initial stress.

The remaining considerations, from an engineering point of view, are the practical and detail methods of uniting the wooden members by iron fastenings to develop the full strength of the wood as a structural material.

From twenty years' experience in the design of floating dry docks, I am prepared to state that I have found it entirely practical to develop (by fastenings in timber structures) as near an approach to the full section value as is possible with steel.

Timbers Given an Initial Stress

Attention is called to the fact that in forming the midship section, including double bottom, sides and deck, all timbers are of uniform section throughout their length, and all are given an initial stress, although well within their elastic limit. This is a well-known engineering device to obtain initial rigidity of structure, it being well understood that materials put together in this manner will be much more rigid, maintaining their form until applied stress has passed beyond the initial stress, and this without in any way sacrificing resistance to maximum stresses.

The main feature of this construction is the center bulkhead running continuous from stem to stern post, the material of which is disposed according to the well-known theory of I-beam or plate girder construction, which gives the greatest amount of strength and rigidity for the weight of material used. This construction requires the placing of hatches in pairs on either side of the center bulkhead, and it is proposed to make them 12 feet in width and 28 feet in length. Any reasonable departure from these figures for special requirements can be readily made.

By referring to Plate 1 it will be seen that in addition to the center bulkhead, other practically watertight bulkheads are to be provided as follows:

Collision bulkhead 35 feet from the bow; a machinery bulkhead at a distance from the stern corresponding to the requirements of whatever type of machinery is used,

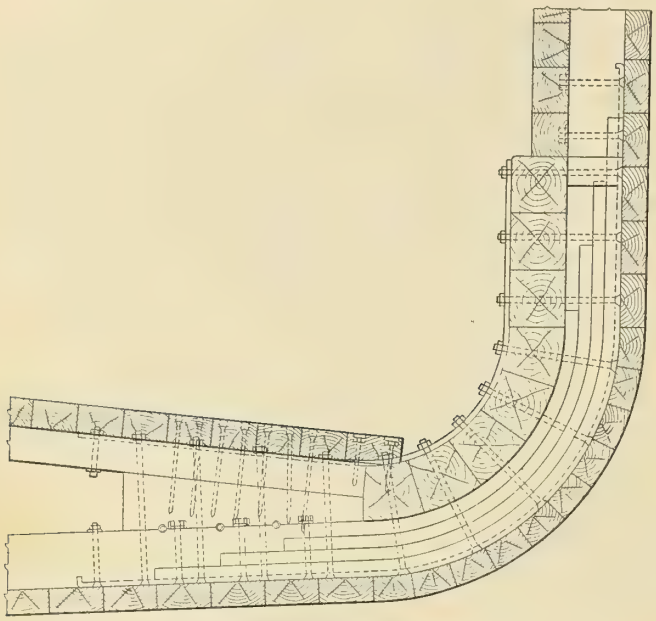

Fig. 5.—Detail of Bilge Construction

and two intermediate bulkheads dividing the cargo space into six watertight divisions. This arrangement of bulkheads divides the ship into ten watertight compartments, which, together with the double bottom, would make the ship practically unsinkable under all ordinary conditions.

It is to be understood that it is entirely practical to make communication openings of wood construction that shall be dependable as watertight doors for entirely cutting off any or all of these compartments, and that there is no practical difficulty whatever in giving the bulkheads ample strength.

Referring to Fig. 5, there will be seen an enlarged detail of the bilge construction. This has been worked out along construction lines which are well known in the highest class of small boat construction, and which can be readily carried out by ordinary workmen in a rapid and efficient manner.

Transverse and Local Stresses

The calculations relative to local stress in bottom, sides, deck, etc., as is usual in the investigation of ships' stresses (with such scantlings as are necessary to take care of overall, or what might be called girder stresses in ships), are much more than necessary to take care of local stresses due to water pressure, cargo distribution, and other local considerations.

The local stress diagrams and explanations inserted herewith are for those more particularly interested in the mathematical consideration of this design.

Transverse Strength

(For sections, see Fig. 6)

A. Double Bottom

Section *A-A* is a combined longitudinal bottom section.

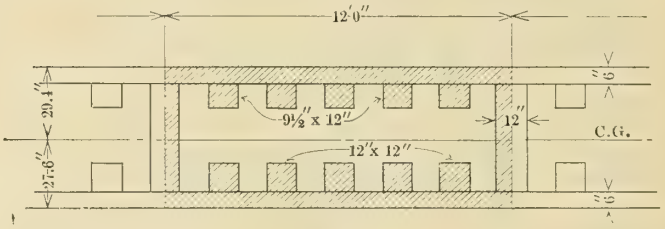

Fig. 7

Maximum Fibre Distance from C. G.....29.4 inches
Moment of Inertia.....1,551,456 inches^4
Section Modulus .....52,770 inches^3

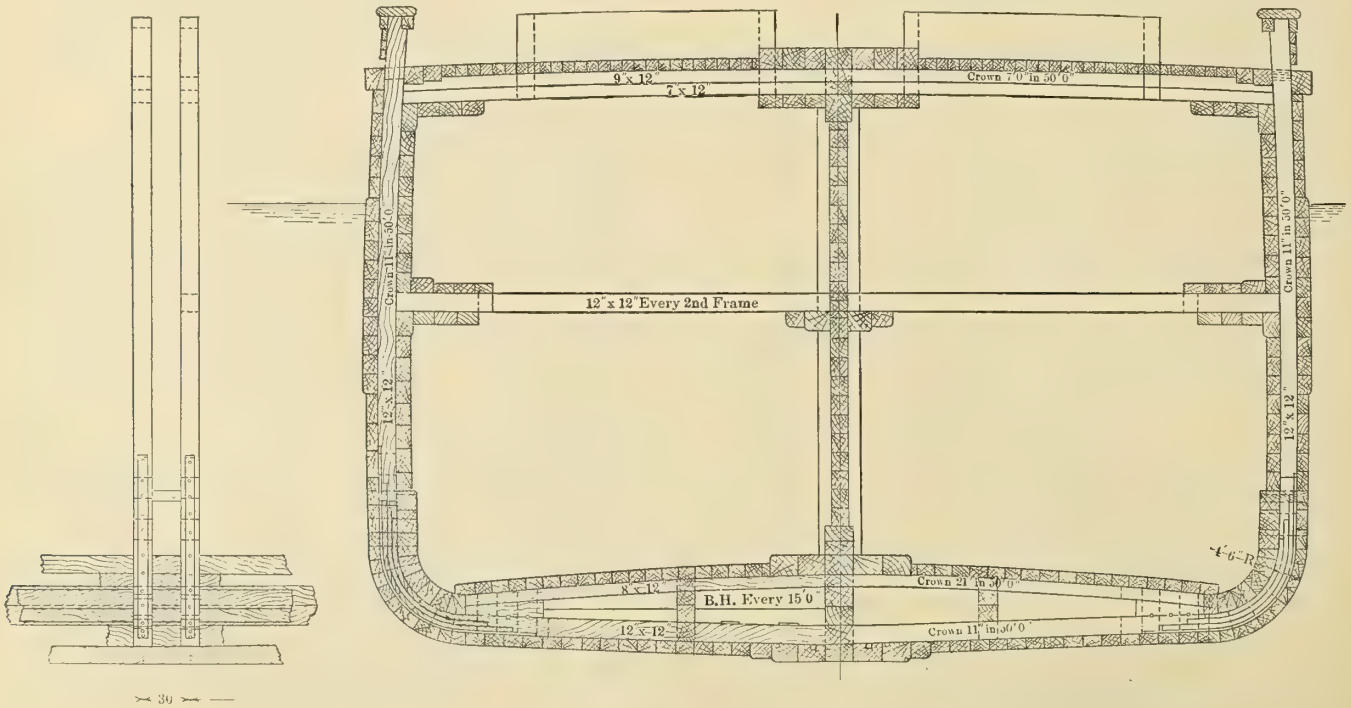

Fig. 6.—Midship Section of Wooden Cargo Ship Built According to New Method of Construction

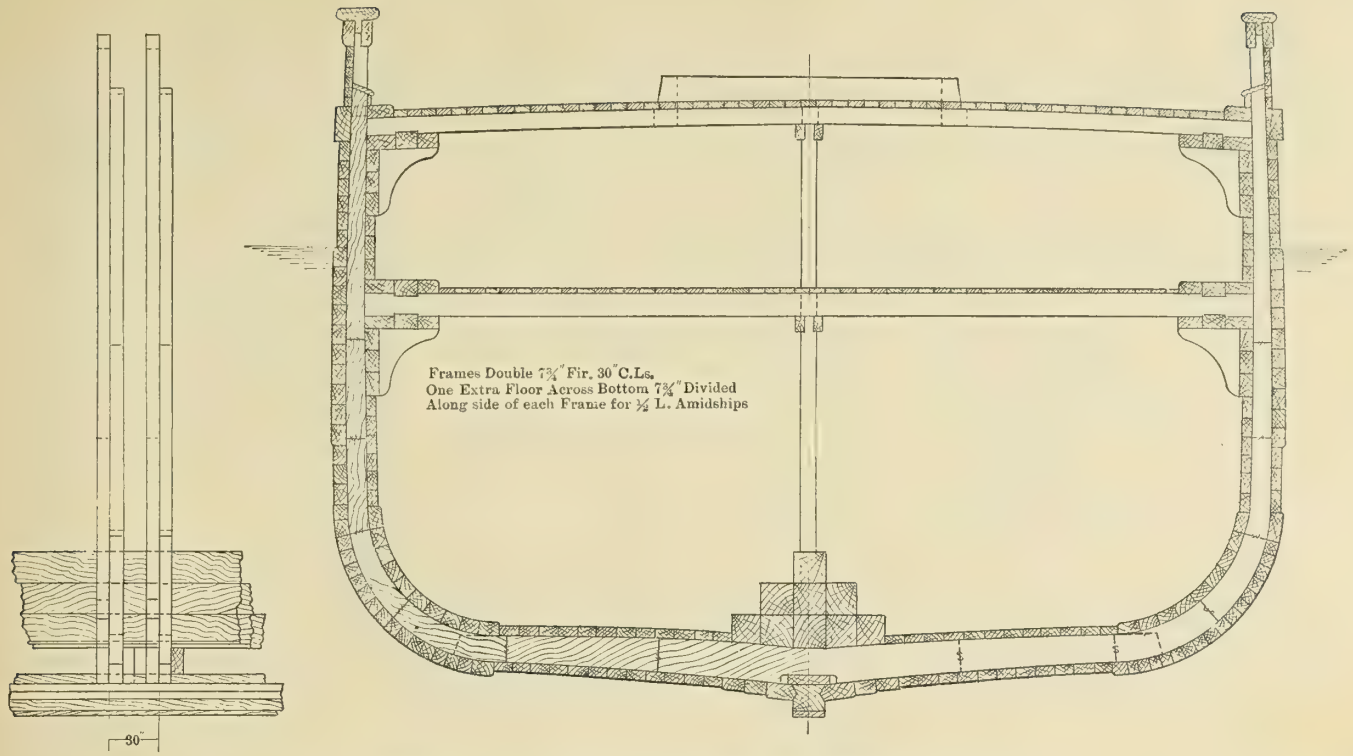

Fig. 8.—Midship Section of Wooden Cargo Ship—Present Typical Construction

Conditions of Loading:

A beam clamped at one end and supported at the other, subjected to an evenly distributed direct load and also to a bending moment applied at its free end.

Span .....25 feet
Bending Load (Pressure-Weight)...600 pounds per foot²
Total Bending Load.....18,000 pounds
Moment at Clamped End.....342,000 foot pounds
Moment at Free End.....325,000 foot pounds
Maximum Moment .....667,000 foot pounds
Section Modulus .....52,770 inches³
Stress .....152 pounds per inch²

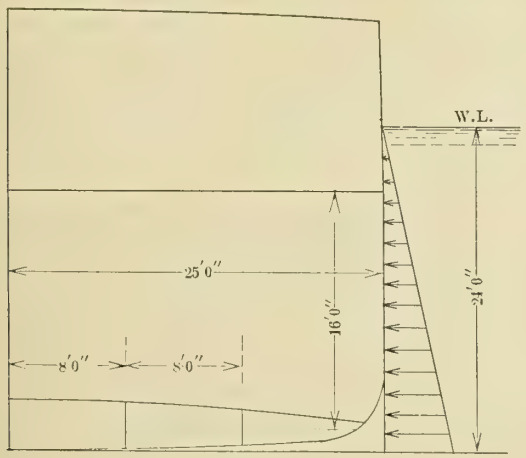

Fig. 9

Section *B-B* is a section taken through the bottom stringer of the double bottom.

Maximum Fibre Distance from C. G.....10.5 inches
Moment of Inertia.....8,000 inches⁴
Section Modulus .....762 inches³

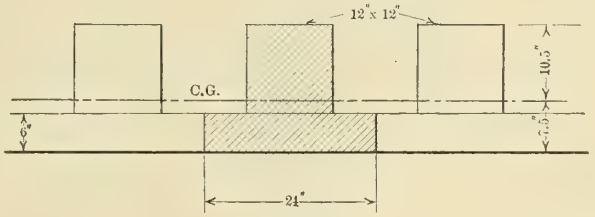

Fig. 10

Conditions of loading:

A beam clamped at both ends supporting an evenly distributed load.

Span .....8 feet
Bending Load (Pressure-Weight)..1,500 pounds per foot²
Total Bending Load.....24,000 pounds
Maximum Moment .....16,000 foot pounds
Section Modulus .....762 inches³
Tension .....250 pounds per inch²
Compression .....180 pounds per inch²

Section *C-C* is a section taken through the top stringer of the double bottom.

Maximum Fiber Distance from C. G.....9 inches
Moment of Inertia.....4,800 inches⁴
Section Modulus .....533 inches³

Conditions of Loading:

A beam clamped at both ends supporting an evenly distributed load.

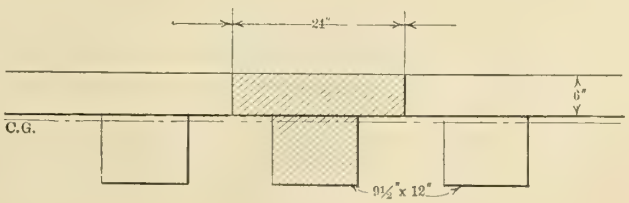

Fig. 11

Span .....8 feet
Bending Load .....800 pounds per foot^2
Total Bending Load.....12,800 pounds
Maximum Moment .....8,530 foot pounds
Section Modulus .....533 inches^3
Tension .....192 pounds per inch^2
Compression .....139 pounds per inch^2

B. Siding

Section *D-D* is a section taken through the siding frame.

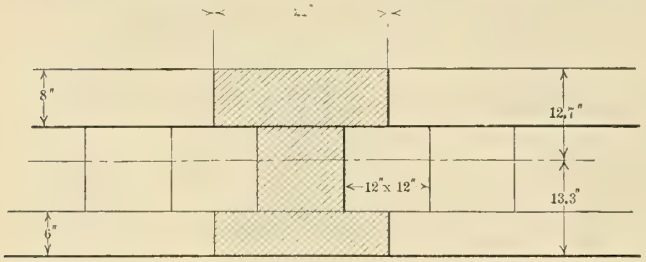

Fig. 12

Maximum Fibre Distance from C. G.....13.3 inches
Moment of Inertia.....33,000 inches^4
Section Modulus .....2,480 inches^3

Conditions of Loading:

A beam clamped at both ends carrying an increasing load.

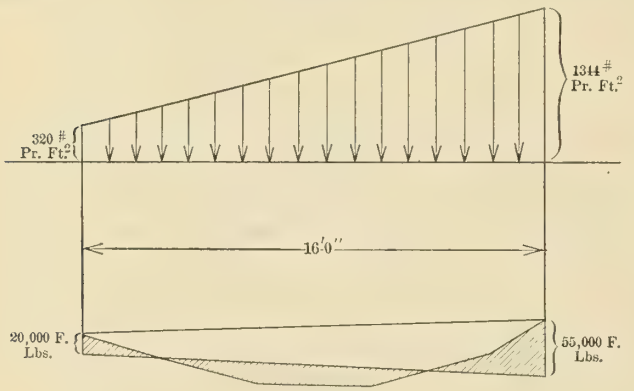

Fig. 13

Span .....16 feet
Bending Load .....320 to 1,344 pounds per foot^2
Total Bending Load.....27,000 pounds
Maximum Moment .....55,000 foot pounds
Section Modulus .....2,480 inches^3
Tension .....324 pounds per inch^2
Compression .....310 pounds per inch^2

Section *E-E* is a section taken through the laminated knee.

Maximum Fibre Distance from C. G.....13.5 inches
Moment of Inertia.....16,500 inches^4
Section Modulus .....1,222 inches^3

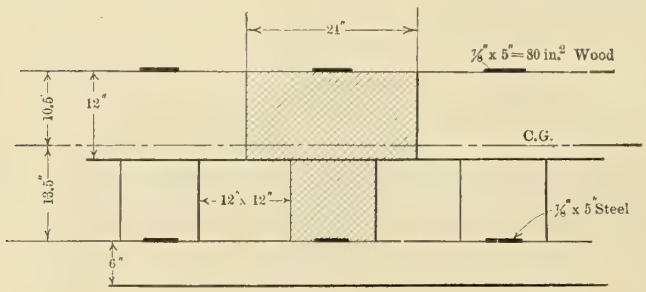

Fig. 14

Conditions of Loading:

Bending only.

Maximum Moment.....55,000 foot pounds
Section Modulus .....1,222 inches^3
Tension .....540 pounds per inch^2
Compression .....378 pounds per inch^2

C. Decking

Section *F-F* is a section taken through the deck frame.

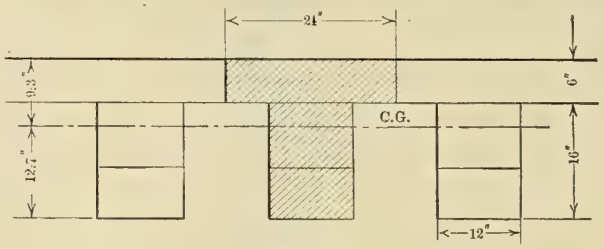

Fig. 15

Maximum Fibre Distance from C. G.....12.7 inches
Moment of Inertia.....18,800 inches^4
Section Modulus .....1,480 inches^3

Conditions of Loading:

A beam clamped at both ends and supporting an evenly distributed load.

Span .....23 feet
Allowable working stress.....600 pounds per inch^2
Section Modulus.....1,480 inches^3
Resistance Moment.....74,000 foot pounds
Allowable Floor Load.....655 pounds per foot^2

Construction of Bilge

Referring particularly to the laminated bilge, I would call attention to the fact that it is the segment of a circle, the radius of which is the same for the entire length of the bilge. Due to this important consideration, it is possible to run out the bilge planking to exact curvature and side bevel to properly fit the bilge, and it is equally possible to finish the heavy inner section in the same mechanical manner, and by providing a substantial iron strap on the outside of the laminated member and on the inside lining, it is possible to connect the side and double bottom into a solid rigid structure, and to make impossible the working of the bilge, which has been known for all time to have been one of the weakest points in wooden construction. It should also be noted that by giving the wooden ship the same general hull form as the steel ship, the depth of the side and its corresponding strength have been much increased.

Double Bottom

The double bottom as applied to this construction has been worked out with a full knowledge of all the practical difficulties to be overcome in making wooden compartments and subdivisions watertight in floating dry dock construction, and while all details are not set forth, it is to be understood that they are all well within the practical limits of wood construction.

Speaking generally, the working or yielding of the wooden ship as previously designed was due primarily to a lack of longitudinal rigidity due to an inadequate strength at the center line, much increased by the considerable dead rise given to the floors, the large curvature of the bilge necessary to obtain even a very inadequate strength of sawed frames, weakened by short lengths and cross grain. The working of the bilges was also partially due to the fact that the bow and stern would come in or yield when the whole structure was put under stress.

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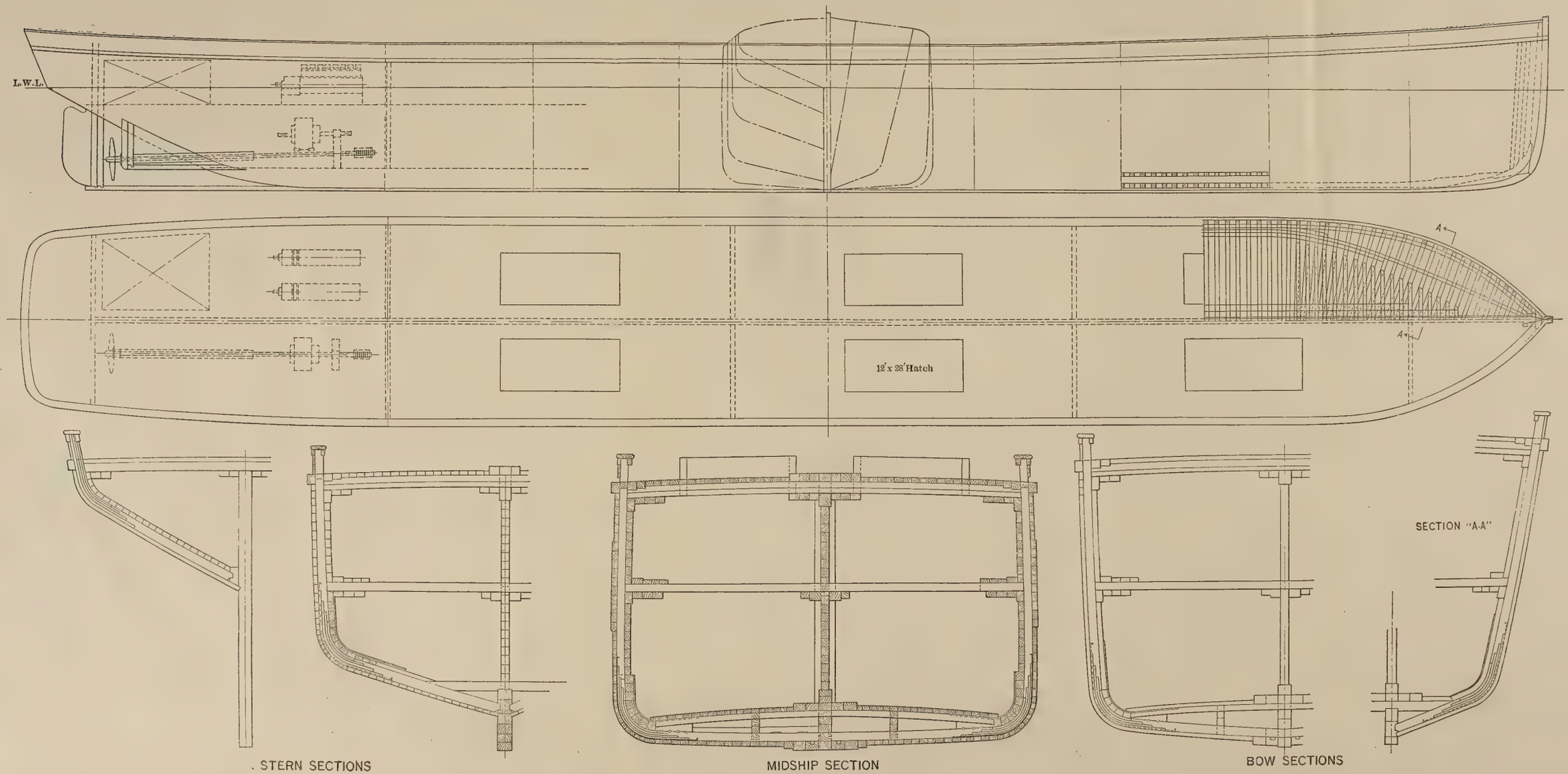
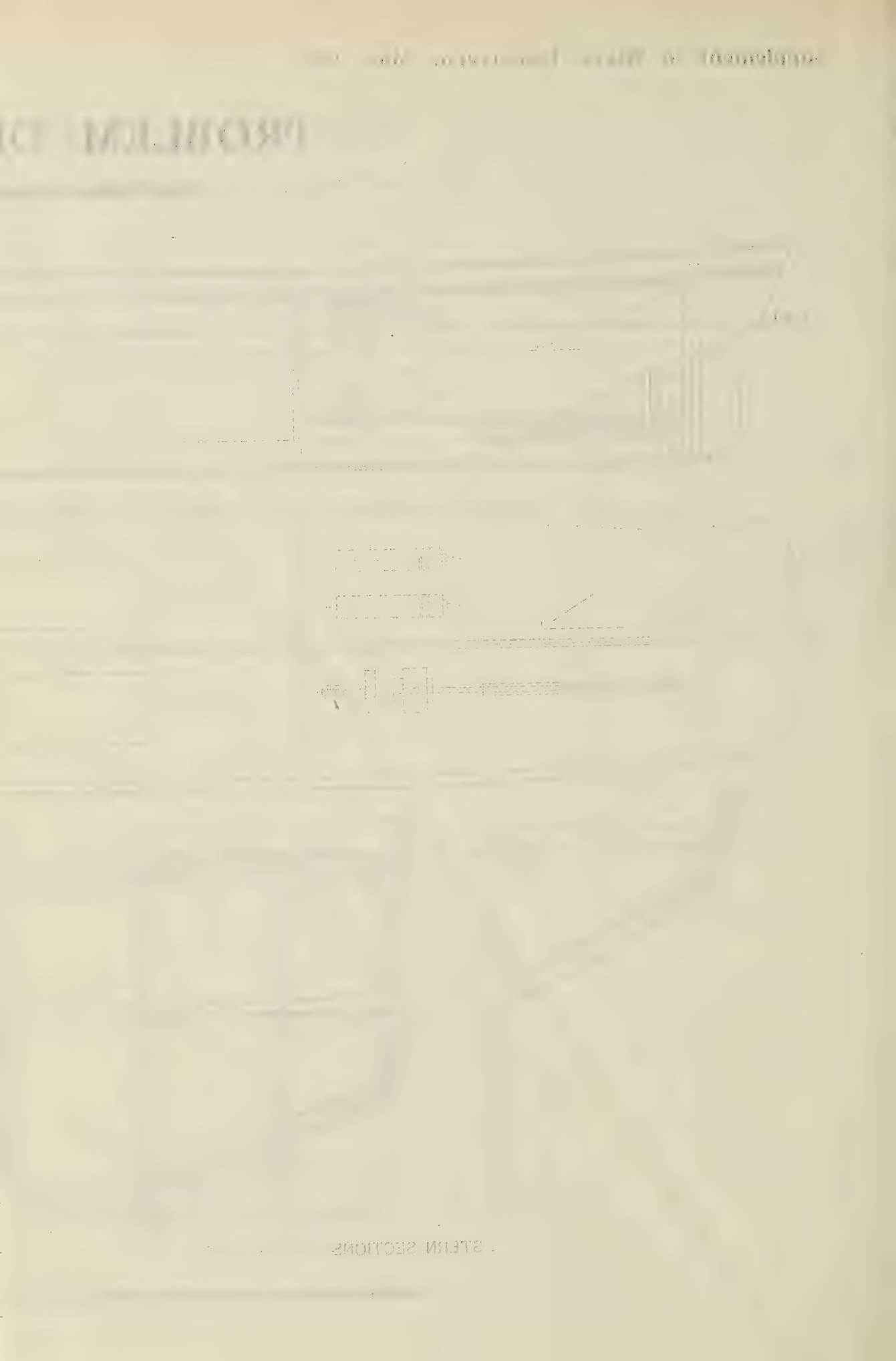
PROBLEM OF THE WOODEN CARGO SHIP

New Method of Construction Developed by William T. Donnelly, Naval Architect, New York City



Profile, Deck Plan and Transverse Sections of Wooden Cargo Vessel: Length Between Perpendiculars, 350 Feet; Beam, 50 Feet; Molded Depth, 30 Feet; Deadweight Carrying Capacity, 5,500 Tons



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PROBLEM OF THE WOODEN CARGO SHIP

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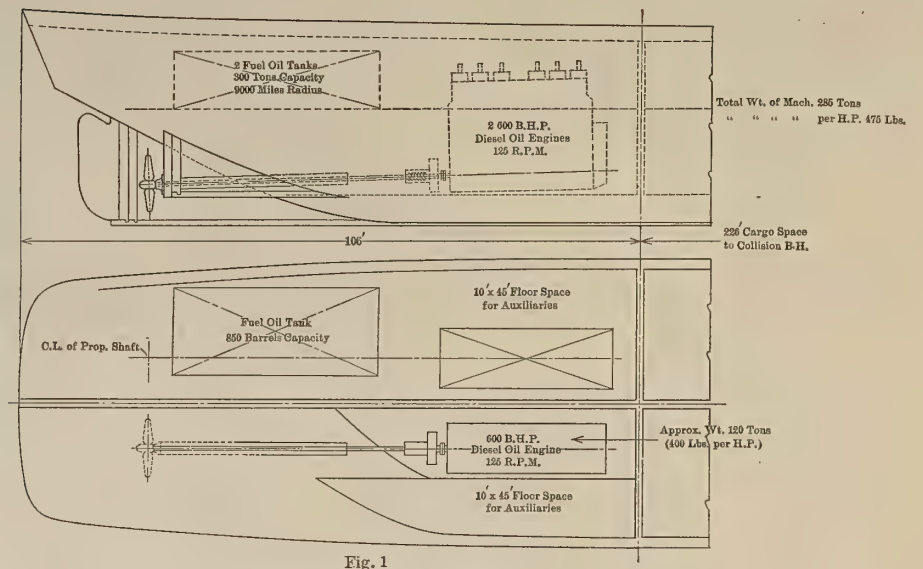


Fig. 1
DIESEL ENGINE PROPULSION

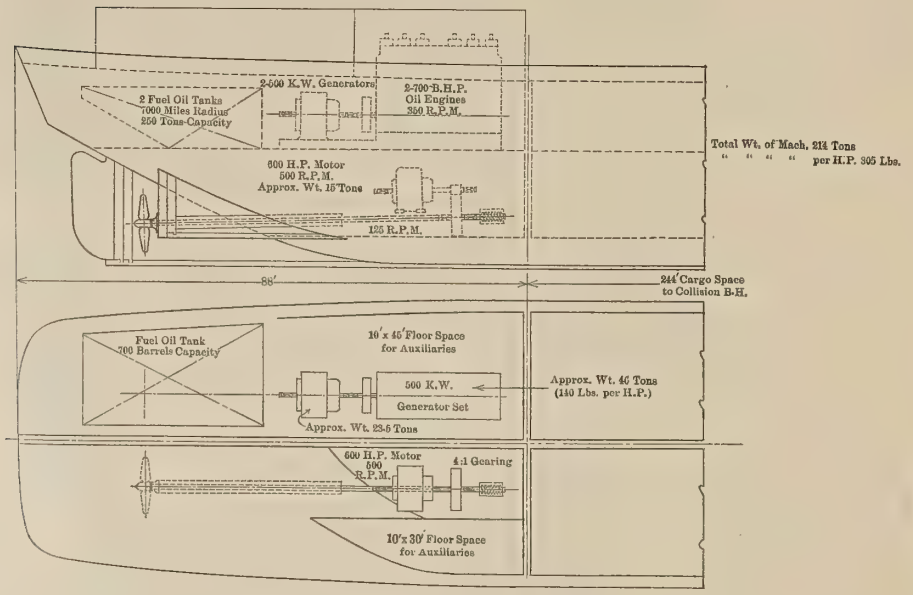


Fig. 2
OIL-ELECTRIC PROPULSION
(LARGE UNITS)

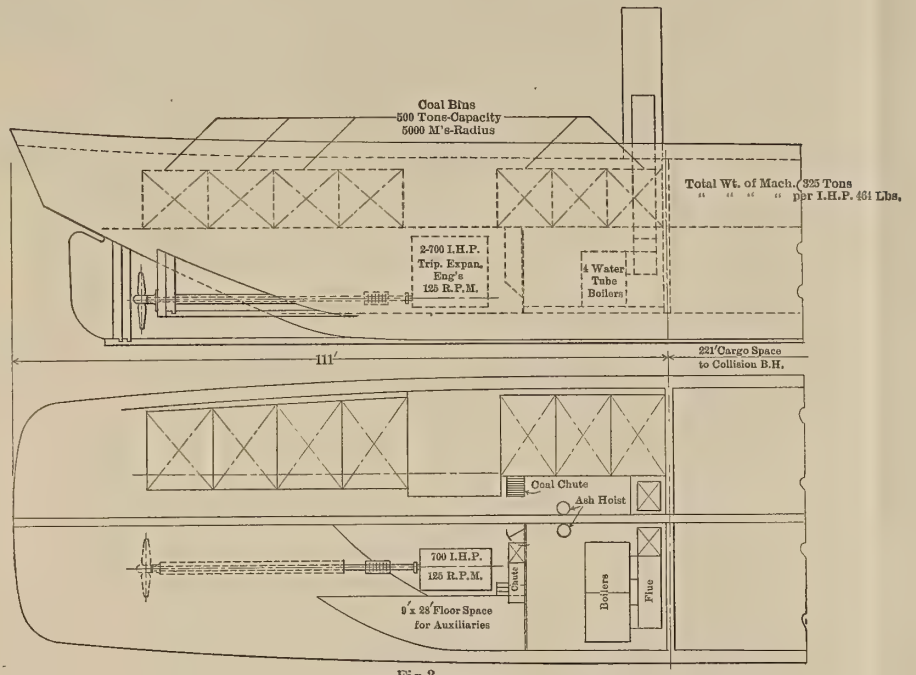


Fig. 3
STEAM PROPULSION

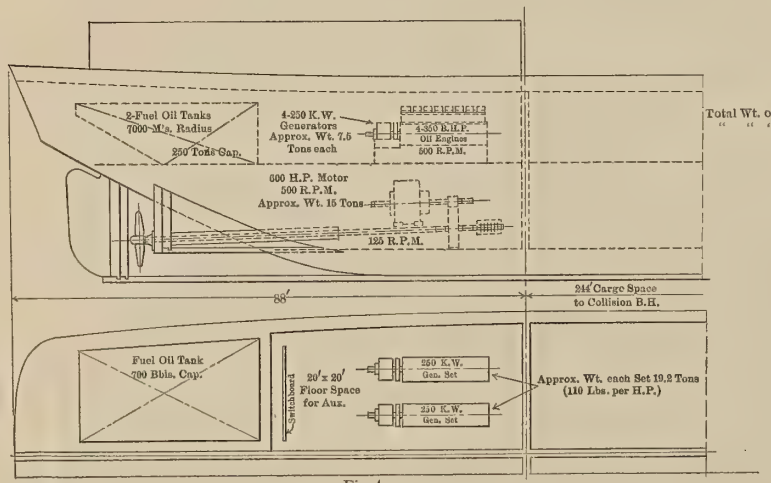
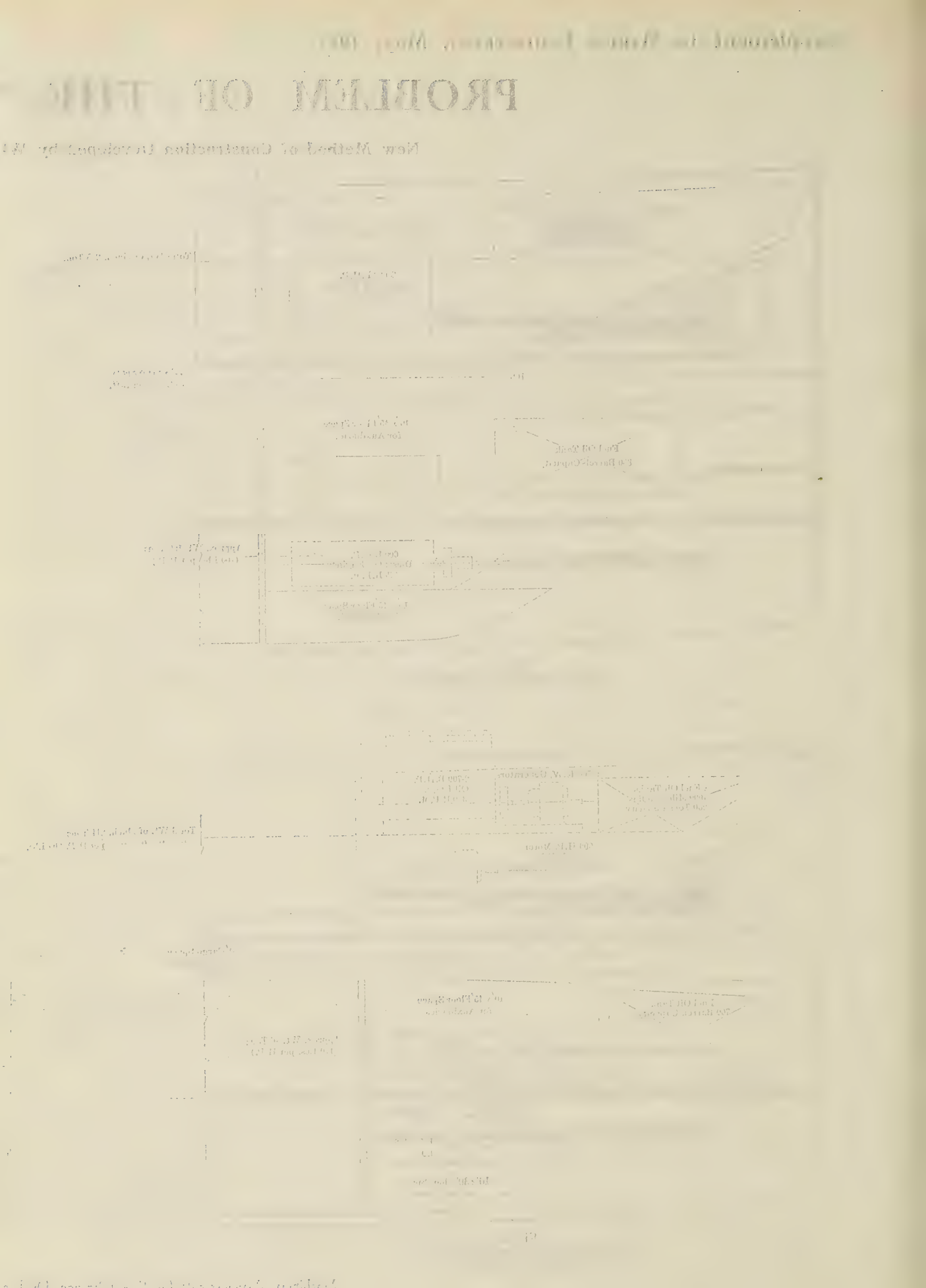


Fig. 4
OIL-ELECTRIC PROPULSION
(SMALL UNITS)

Machinery Arrangements for Diesel Engine, Oil-Electric and Steam Propulsion for Wooden Cargo Vessel



The introduction of the center line bulkhead as a plate girder not only adds strength where it was most needed, but entirely prevents the possibility of the bow and stern yielding—in other words, it reinforces the sides in addition, and when these facts are taken into consideration, with the very great increase in rigidity of the bilge and the increased depth of the sides, the fundamental reasons for anticipating a rigid wooden hull of much larger dimensions are fully sustained.

Application of Propelling Power

Referring to Plate II, there will be found diagrammatic illustrations of different forms of power equipment which may be applied to the propulsion of this hull.

Primarily, it is the intent to give the hull a speed of 9 knots loaded and 10 knots light, and this will require the expenditure of approximately 1,400 indicated horsepower, or 1,200 brake horsepower as applied to the propeller shafts.

It is first to be noted that twin screw propulsion is provided under all methods of construction, and that the uniform rotation of propeller shaft of 125 revolutions per minute has been adopted, which would correspond to a diameter of 10 feet for each propeller.

Steam Propulsion

In case of steam propulsion, it is to be noticed that a length of hull measuring from the stern of 111 feet will be required for engines, boilers and coal bunkers, and that provision is made for carrying 500 tons of coal giving a radius of 5,000 miles.

In case of use of oil for fuel, a considerable reduction in fuel space and weight of fuel to be carried will be effected, but the space required for machinery would not be materially affected. A geared steam turbine might be used in place of reciprocating engines with a small reduction in weight per horsepower, but this reduction would not affect the boilers, and the weight to be saved is not large.

The total weight of machinery, including engines and boilers, shafting and propellers, would amount approximately to 325 tons. This, referred to indicated horsepower, would mean 464 pounds per horsepower.

Diesel Engine Propulsion

Diesel engine propulsion, with two 600 brake horsepower Diesel engines direct connected, operating at 125 revolutions per minute, would require a space corresponding to 106 feet length of hull. The total weight of machinery would be 285 tons, or 475 pounds per brake horsepower. Provision has been made for 300 tons of oil, which would give a radius of 9,000 miles.

This method of propulsion is fairly well known and offers very great economy in fuel and provides for very large radius of action. The weight of the machinery, however, is fully as much as steam machinery, when the engines are built of sufficient size to operate at the same number of revolutions, which is essential for equal service.

Electric Propulsion

A third method is shown in which two oil engines of a semi-Diesel type are used to operate two 500 kilowatt electric generators, at 350 revolutions per minute, and the ship is propelled by two 600 horsepower electric motors running at 500 revolutions per minute, geared to propeller shafts making 125 revolutions per minute. This mechanical equipment shows a total weight of 214 tons or 305 pounds per horsepower. The very considerable reduction in total weight of machinery required is due to the highest speed of oil engines, and it is seen that the reduction in the weight of these engines more than overbalances the weight of electric generators and motors.

A fourth equipment is shown in Fig. 4, Plate II, consisting of four 350 brake horsepower oil engines operating at 500 revolutions per minute, each driving a 250 kilowatt generator, the propulsion of the ship being by two 600 horsepower electric motors, the same as in the previous equipment.

The total weight of this equipment is 182 tons, or 260 pounds per horsepower, and in connection with it there has been shown fuel oil tanks holding 250 tons giving a radius of 7,000 miles.

The comparison of the space occupied by the electric machinery with other forms of drives shows that it will require very much less room, and that with the smaller high speed units (the least of all, in fact) the power generating plant could be put in half the space, and the four units would require but one man on watch to care for them. Each of the units is so small that it could be readily overhauled and the spare parts to be carried would be few and light.

It should be pointed out that while in port any one of the four units could furnish all the auxiliary power necessary for handling cargo, pumping and lighting the ship, and for doing any other work, and that with a liberal equipment of electric pumping machinery, any part or all of the propelling power of the ship could be used to pump the vessel in an emergency.

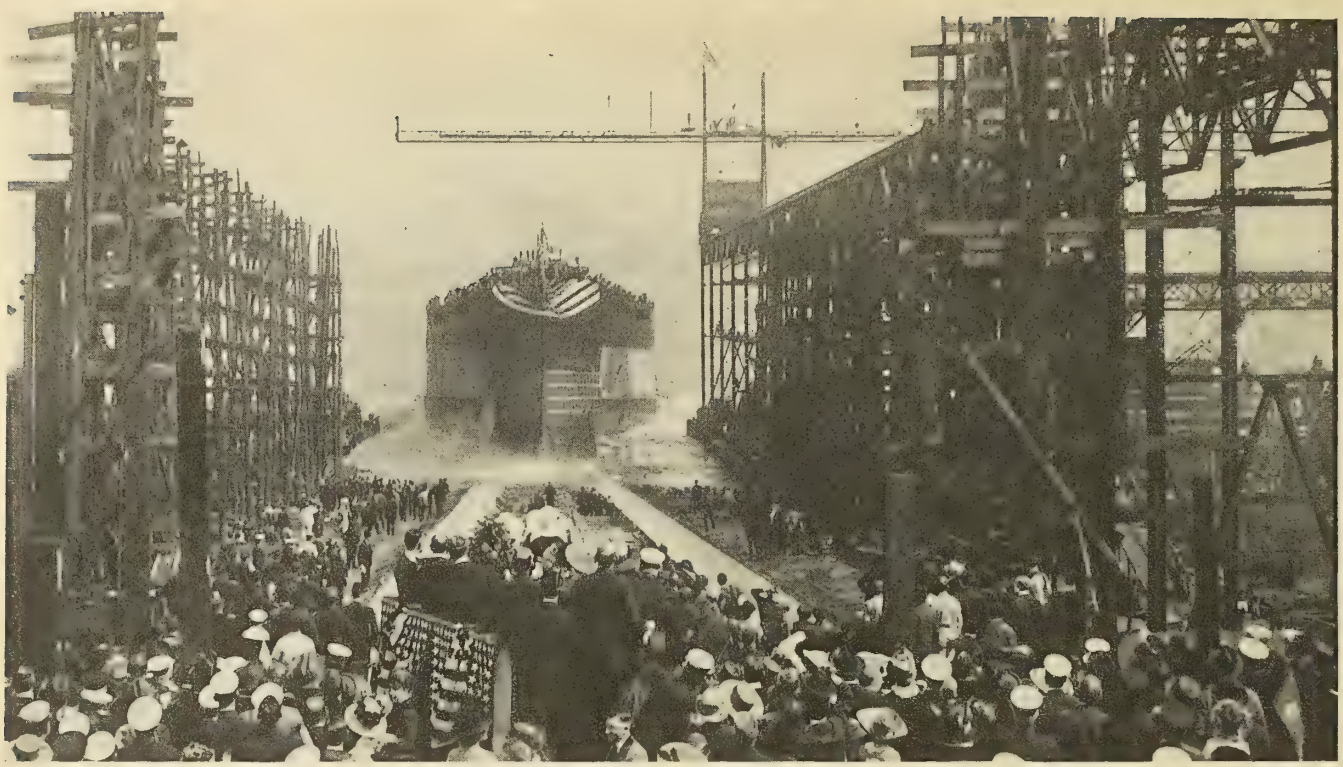
It is not claimed that any of these equipments represents the final word of power application, but they do furnish a reasonably accurate basis for the comparison of different methods, and indicate the lines along which study and development should be made.

It is very plain, if anything like one thousand ships are to be built and equipped with power propelling machinery, that no one method can be applied to all, and that to make the greatest progress every practical method must be applied. Furthermore, it would seem that, where such a large number of vessels of practically the same size and construction are to be created, every method of propulsion promising any real possibilities in competition with any other should be given an opportunity. With a careful record, a very great deal of positive knowledge can be obtained as to the relative merits of different methods of propulsion.

United States Battleship New Mexico Successfully Launched at New York Navy Yard on April 23

Contrary to the usual custom in times of peace, the latest United States battleship to leave the builders' ways was launched in the presence of only a comparatively few spectators, although the appropriate ceremonies were observed. This latest addition to the nation's first line of defense is the superdreadnought *New Mexico* building at the New York Navy Yard, Brooklyn, N. Y., under the direction of Naval Constructor G. H. Rock, U. S. N. The vessel was launched on April 23, and christened by Miss Margaret de Baca, daughter of former Governor de Baca, of New Mexico.

The principal dimensions of the *New Mexico* are as follows: Length, 624 feet; breadth, extreme to outside of frame, 97 feet 4½ inches; displacement, 32,000 tons; mean draft, 30 feet. Her armament consists of twelve 14-inch



U. S. S. *New Mexico* Leaving the Building Ways at the New York Navy Yard, Brooklyn, N. Y.

guns, twenty-two 5-inch, four 3-pounders, four anti-aircraft guns and two torpedo tubes. She will be manned by fifty-six officers and 1,141 men.

The *New Mexico* is a sister ship of the *Mississippi* recently launched at the yards of the Newport News Shipbuilding & Dry Dock Company and of the *Idaho* still on the ways at the works of the New York Shipbuilding Corporation, Camden, N. J. The keel of the *New Mexico* was laid on October 14, 1915, and, when launched, she was about 67 percent completed. It is expected that the vessel will be finished within the thirty-six months specified at the time the keel was laid.

The last vessel launched from the New York Navy Yard was the battleship *Arizona,* launched in June, 1915. The *Arizona* was 608 feet long and of about 1,000 tons less displacement than the *New Mexico.* The main battery in both of these ships, however, is the same and the speed will be approximately the same. The *New Mexico,* however, will be equipped with electric drive.

Lloyd George's Speech and Its Relation to Motorship Development

(*Concluded from page* 205)

What does it portend? It shows that there are certain shipowners who will not take the risk of placing orders for steamers with delivery in over three years' time, but who have sufficient confidence in the Diesel motorship to accept deliveries four, five and six years ahead!

Does it not also show that Lord Pirrie and these neutral European shipowners realize that, no matter what state the shipping business may be in in six years' time, it is certain that motorships can be successfully and profitably operated in the face of any kind of steamship service? These shipowners are not new introductions of young blood into the business whose motto is "everything modern, no matter how heavy the cost"; but are serious-minded and venerable shipowners with several decades of hard experience before them. Those who followed Lord Pirrie in the past have made fortunes, those who follow him now also will make fortunes. If Lord Pirrie says motorships are practical you can be sure that they are so. He owns enough to know. He also owns steamers. America has only tried steamers, so is without proper experience. Will Americans merely shrug their shoulders and proceed about their business thinking they know better than he? Either he is right and they are wrong, or they are right and he is wrong! Which is it?

In view of this I may well ask shipowners and shipbuilders of the United States, "What are you doing?" Let us all again read Lloyd George's significant words, watch Lord Pirrie's doings, and then act upon them! The shipbuilders and shipowners of Great Britain have agreed to pool their motorship and Diesel-engine knowledge, also to obtain Government assistance in research work, and have set themselves to make the British marine oil engine the world's standard. American shipowners today are wealthy. Let them cut out the "playing safe" motto in this connection. Let us all do our bit! Also let the shipowning oil companies make the first worthy start. They will benefit the most.

T. O. Lisle.

Shipbuilders Form an Advisory Committee on Naval Architecture at the Massachusetts Institute of Technology

President Richard C. MacLaurin, of the Massachusetts Institute of Technology, Boston, Mass., has received acceptances from the following shipbuilders to serve as an advisory committee on Naval Architecture at the Institute. The shipbuilders who will comprise this committee are as follows: Joseph W. Powell, president Fore River Shipbuilding Corporation, Quincy, Mass.; Homer L. Ferguson, president Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; Charles P. Wetherbee, vice-president Bath Iron Works, Bath, Me.; James Swan, general manager Herreshoff Manufacturing Company, Bristol, R. I., and George J. Baldwin, president New York Shipbuilding Corporation, Camden, N. J.

Douglas Fir (Oregon Pine) Shipbuilding

Supply of Douglas Fir—Properties and Strength of the Material —Application to Shipbuilding and Methods of Construction

BY HOWARD B. OAKLEAF *

DURING the last year or eighteen months the shipbuilding industry of the world has received phenomenal impetus owing to the exceptional demand for bottoms to replace those destroyed and interned since the beginning of the European war. Ships are being sunk more rapidly than they can be rebuilt with present facilities for construction and it will be several years before the demand for vessels of all classes will be met.

Within the last thirty years steel shipbuilding has caused the wooden shipbuilding industry gradually to decline, until in recent years such yards have, with but few exceptions, been called upon to build only small commercial boats and pleasure craft. Fortunately such work gave employment to sufficient skilled workmen to form the nucleus of the vast army of men now being employed in this class of work. In addition, there are quite a number of skilled shipbuilders who have taken up other trades that are now available for the revivification of this waning industry.

The enormous demand for both war and merchant vessels has so overtaxed the steel shipyards, and in turn the already overworked steel manufacturers, that the cost of steel vessels has risen by leaps and bounds, yet the demand for such tonnage cannot be met. This peculiar condition in the steel shipyards is largely responsible for the ready markets for wooden vessels at the present time, although improvements in design and in methods of construction have undoubtedly played an important part in the revival of the wooden ship industry.

Both pure sailing vessels and vessels equipped with auxiliary steam or internal combustion engines are being built in considerable numbers, the latter being the prevailing type. Most of them are designed for carrying lumber, although many will probably be used for other cargo. They are generally of the twin screw type and powered to make a speed of six or eight knots in calm weather, when loaded. The auxiliary power is a saving and a convenience when shifting berth and to prevent being becalmed.

The capacity of most of those under construction at the present time is from 1,000,000 to 1,500,000 board feet of lumber, although some of larger capacity up to 2,250,000 board feet are being built.

It is principally the auxiliary schooner that is discussed in this paper, although much of the text is applicable to wooden ship construction in general.

Supply of Raw Material

In the Western timbered area of the States of Oregon and Washington there are now standing about 450,000,000,000 feet of Douglas fir (Oregon pine) trees, representing an almost unlimited supply of wood admirably adapted to the construction of wooden vessels, as is later shown by the discussion and data on the mechanical and physical properties of this important tree species. It is this remarkable supply of suitable raw material which is attracting and will continue to attract shipbuilders to this region. In addition to the abundance of raw material which insures a reasonable price for the wood for years to come, the trees grow to such an unusual size, commonly 3 to 5 feet in diameter and 175 to 250 feet high, that the shipyards can always obtain on short notice huge sticks of almost unheard-of dimensions at comparatively low cost. This means that even the largest of wooden boats can be constructed of Douglas fir with minimum splicing, which not only reduces labor costs but materially increases the strength or seaworthiness of the vessel, since man cannot fabricate the material as successfully as nature.

The large supply of raw material not only assures almost indefinite availability at a reasonable price, but it enables the boat builder to purchase his timbers from those operators who are cutting a class of trees the wood from which is especially suited to the construction of vessels. This is not possible to the same extent anywhere else in the world.

Mechanical and Physical Properties of Douglas Fir (Oregon Pine)

Douglas fir is exceptionally strong for its weight, a factor more important in the shipbuilding industry than in most any other business that requires large quantities of this species, although it is a great asset in the construction of railway freight cars. In both of these wooden structures it is important that the material used be as light as the desired strength will permit, since all surplus weight greatly reduces the speed and increases the cost of transporting commodities in them. Douglas fir is one of the few woods whose strength is above the values set by the well established law of weight vs. strength.

The strength values presented below are the result of exhaustive tests made by the Forest Service, U. S. Department of Agriculture, at its various timber testing laboratories. They are for both green and air dry stock and for both large and small specimens.

STRENGTH OF DOUGLAS FIR*

	Large Select Beams 8 x 16		Large Merch. Beams 8 x 16		Small Clear Beams 2 x 2	
	Green	Air Dry	Green	Air Dry	Green	Air Dry
Moisture, percent	....	21.4	....	21.2	35.4	18.8
Fibre stress at elastic limit, pounds per square inch	4,346	4,690	3,895	4,625	4,920	6,300
Modulus of rupture, pounds per square inch	6,753	7,070	5,878	6,472	7,800	10,000
Modulus of elasticity, pounds per square in., in thousands	1,654	1,644	1,481	1,567	1,580	1,680
Impact bending—drop of 50-pound hammer to break			2" x 2" x 28"		25"	28"
Compression parallel to grain—crushing strength at maximum load, pounds per square inch					3,910	4,850
Compression perpendicular to grain—fibre stress at elastic limit, pounds per square inch					530	760
Hardness on end—load in pounds required to imbed a 0.444-inch ball to half its diameter					510	650
Hardness on side—load in pounds required to imbed a 0.444-inch ball to half its diameter					510	610
Shearing strength—parallel to grain, pounds per sq. inch.					870	940

N. B.—The above strength of figures of the air dry material would be higher if the wood had been dried more, but they are well adapted to boat design.

Weight.—Douglas fir has an average specific gravity of .53, based on its oven dry volume, or .46 when based on its green volume (before shrinkage), and .48 on its air dry volume. The green wood weighs 38 pounds per cubic foot

* In charge office of Forest Products, United States Forest Service, Portland, Ore.

* F. S. Bulletin No. 88, page 56, and M. S. Reports. Project L-124 and Project L-140.

(3.166 per board foot) and the air dry wood 34 pounds (2.833 per board foot). These weights vary in fir as in other woods, but the above figures are reliable averages.

Durability.—Douglas fir is a durable wood, although, like other woods when used for this purpose, precautions should be taken at the time the boat is constructed to see that preservatives are effectively applied and that the necessary amount of ventilation is supplied to prevent the collection of moist, stagnant air in any part of the vessel.

Shrinkage.—Douglas fir does not shrink much, and for this reason it is possible to use partially dried material in emergencies without fear that additional drying after the material has been shaped will open the seam or cause undesirable stresses in the members. The following figures are given for the information of those desiring to know the amount that Douglas fir will shrink under normal conditions from green to air dry: Radially, 1.52 percent; tangentially, 2.37 percent, and longitudinally, 0.0091 percent.

Abrasion.—While there are no reliable test data on the resistance of Douglas fir to abrasion, it is a well-known fact that this wood has long given satisfaction as decking for all kinds of vessels, both wooden and steel. Shipbuilders from all over the world buy millions of feet of vertical grain Douglas fir decking annually.

Workability.—The wood is easily worked with all classes of cutting tools used in the shipbuilding trade, and ship carpenters who have had experience with various woods are highly pleased with the ease with which they can carve and saw the large fir timbers.

Bending.—When the wide, thick pieces of planking and ceiling have been properly steamed, they become quite pliable and can be bent readily to conform to the ship's lines.

Painting.—Douglas fir takes paints well and can also be stained and polished nicely. These characteristics make it well adapted to either outside or inside finish. So well does it meet the requirements of woods used for interior trim that many boats are built entirely of fir.

Douglas Fir Ship Knees

In addition to the large timbers and planks obtainable from Douglas fir trees, the stumps yield the finest and largest ship knees in the world. These knees are an important item to the shipbuilder for as many as two hundred to three hundred are used in a single boat. Most of

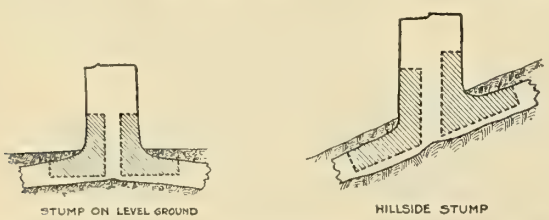


Fig. 1.—Diagrams Showing How Ship Knees are Cut from Stumps

the knees have an angle of ninety degrees, although a few are used for special purposes that require angles greater or less than this. Stumps on level ground yield knees having right angles, while the roots of those on a hill produce knees with acute angles on the uphill side, and obtuse knees on the down-hill side.

Masts and Spars

For many years the large masts and spars for vessels built in various shipyards of the world have been supplied from the Douglas fir forests of Washington and Oregon. Here, as in the other parts of the boats, the strength, weight and size of the sticks have been of inestimable value to shipbuilders in getting out these essential parts of both sailing and power vessels. Masters of vessels flying all flags have taken the opportunity when calling at Oregon and Washington ports, of picking up an extra mast or spar.

The trees carry their form well up into the top, and masts can be obtained from young, thrifty trees without

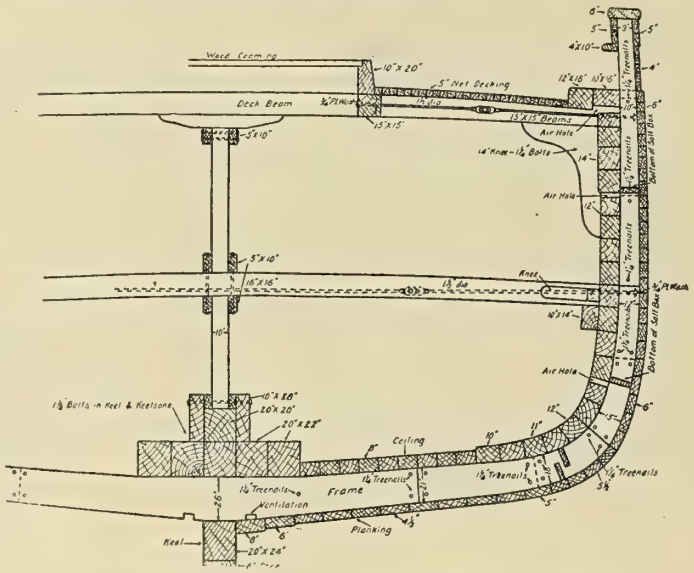


Fig. 2.—Midship Section of Typical Wooden Ship

sacrificing the top diameter to get young, healthy trees suitable for such use.

Sizes of Timbers and Plankings

The followings table shows the dimensions and quality of the material used for the principal parts of a modern boat.:

Form and Grade	Thickness, Inches	Width, Inches	Length, Feet
Frames-Merch.	11 to 12	14 to 32	10 to 26
Deck Beams—Select	15 to 16	15 to 18	42 to 50
Keels—Select	18 to 20	20 to 24	90 to 120
Keelsons—Select	18 to 20	20 to 22	90 to 140
Planking—Clear	4½ to 7	7 to 16	40 to 90
Decking—Clear V. G.	8 to 14	12 to 16	60 to 80
Ceiling—Select	4 to 6	4 to 6	40 to 60

Probably nowhere else in the world are such thick, wide, long and high-grade pieces of timber available in such large quantities as in the fir lumber producing centers of Oregon and Washington. There are millions of feet of logs in the log markets at all times ready to be cut to any size the naval architect specifies in his plans.

Improvements in Methods of Construction

There is little question but that wooden vessels carefully and conscientiously constructed under the best methods of building prescribed to-day are more substantial than those of years ago. First the bolt and treenail holes are bored with compressed air or electric drills, instead of by hand-operated ship augers. The mechanical drills insure a smooth bore, which increases the holding power of the fastening. The bolts are also driven home and headed with air or electric hammers instead of mauls. This insures more uniform heads and a tighter fastening than was usually obtained by hand. The fact that the machines make the work easier tends to increase the care with which it is done, and in addition there is an enormous saving in labor costs.

Steel reinforcing strips are also used on some of the larger boats. They serve to bind together and strengthen the hull and on the whole greatly minimize the possibility

of the boat going to pieces immediately in case of shipwreck.

More attention is also paid to the prevention of decay or dry rot around the bolt holes, in the splicing seams and at other points where two surfaces come in contact. The use of common salt as a preservative is rapidly giving place to high-grade creosote and carbolineums. Greater care is also given to ventilation and the prevention of stagnant air pockets, and it is believed that when modern methods of preventing decay as used in other structures, are applied to shipbuilding in a scientific and systematic manner, the underwriters will considerably increase the rated life of the best constructed wooden vessels.

The actual toxic properties of common salt are not well established, and in addition the presence of salt tends to accelerate the corrosion on all the metal fastenings, materially reducing their life and lessening their holding force. It is unquestionable that the liberal application of hot coal-tar creosote or other acceptable substitute to all joints, splicings and other surfaces of contact, as well as in the bolt holes, will greatly retard or even prevent entirely the ravages of wood-destroying fungi.

How the Boats are Assembled

As is well known, the laying of the keel is the first step. While the keel is being laid, the frames are shaped and assembled. Each frame is made double, with lap-joints (see Fig. 2) and of pieces 11 inches to 12 inches thick. They are held together with hardwood pegs or treenails (usually locust or oak) and iron bolts about 1¼ inches in diameter, and are made so secure that the frame really represents one piece 22 inches to 24 inches thick (wide). These frames are set up on the keel on about 32-inch to 34-inch centers and held in upright position and at proper distances apart by "ribbons" fastened along the outside face of the frames. Temporary pieces are also run from the top ends of each frame to retain the proper beam. The keelson and its associated members are then placed on top of the frames directly above the keel. The keel, frames and keelsons are then bolted together securely with galvanized iron bolts. In the meantime the stem and stern post have been put in place and securely fastened to the keel and keelsons. The ceiling and planking are then put on and fastened to the frames by means of both bolts and treenails. Some of the bolts run from the outside of the planking through the frames and ceiling to the interior of the vessel. The deck beams are sprung in place and each is fastened to the side of the ship with large knees. The boat is then ready for the decking rails and cabins. The above described parts represent the principal use of wood in modern shipbuilding.

Size of Wooden Ships

To give the reader some idea of the size of some of the vessels that are being and have been constructed of wood, the following table of dimensions of several wooden boats has been compiled. While quite a number of ships of the larger sizes shown have been built and successfully operated, there is a rather general feeling among naval architect, shipbuilders, underwriters and navigators, that such vessels are not as desirable as smaller ones:

	A	B	C	D
Length	215	285	225	290
Breadth	41.3	48	42.4	48
Depth	16	19	18	26
Date	1896	1916	1902	....
Gross tons	1,014	....	1,237	....
Net tons	902	....	1,105	....
Capacity	1,300M	2,000M	1,500M	2,500M
	E	F	G	H
Length	347	290	252	256
Breadth	50	48	43.4	43.6
Depth	25	....	21.6	21.6
Date	1902	1917	1916	1916
Gross tons	....	2,500	1,470	1,600
Net tons	....	....	1,250	1,300
Capacity	5,500T	2,250M	1,750M	1,900M

Costs of Wooden Vessels

The following figures of the cost of constructing a typical lumber schooner equipped with auxiliary motors, are taken from an article on auxiliary schooners by Martin C. Erismann in the April 1, 1916, issue of the *West Coast Lumberman*. While labor and other costs have increased considerably since last spring, the figures give a general idea of the division, at least, of costs in a modern wooden vessel of fair carrying capacity. The costs of building vessels fluctuate so violently with varying labor and material costs that prospective buyers should not use these figures as an indication of the price a shipbuilder should charge for a boat of given size:

COST OF AUXILIARY LUMBER SCHOONER

Length (custom house)	225 feet 0 inch	
Breadth	42 feet 6 inches	
Depth	18 feet 0 inch	
Gross tonnage (about)	1,250	
Net tonnage (about)	1,125	
Speed, knots, loaded	7	
Lumber capacity (board feet)	1,400,000	
Machinery, two 160-horsepower oil motors	320	
Cost of ship complete (wood construction)	$98,000	(£20,000)
Machinery and installation	24,000	(£4,925)
All auxiliary machinery	10,000	(£2,050)
Design, contracts, supervision, etc.	7,920	(£1,620)
Total cost of vessel	$139,920	(£28,595)

Other Woods for Special Uses

Iron Bark.—Australian iron bark is one of the principal woods used in parts of the ship requiring unusual strength and hardness. This wood is sometimes used for stems, stern posts, rail facings, stem facings, bearing plates, keys and similar parts.

Oak.—Oregon and Eastern oak are used as substitutes for iron bark in many of the above parts. They are also used for treenails.

Locust.—Black locust, obtained from the hardwood regions of the East, is the principal wood for treenails. It is usually purchased in small squares of described lengths and turned to the exact size at the plant.

White Pine.—White pine disks are used to plug the holes in plankings and decks, made by countersinking the bolts and spikes. These plugs are held in place by a coating of white lead. They are put in dry and when moistened with water swell and form a very tight plug.

Amount of Lumber Required Annually

There are now (November, 1916) installed and being installed about 50 to 60 slips at the wooden shipyards in Oregon and Washington capable of turning out from 75 to 90 large wooden vessels annually. Since these vessels will require on the average of 1,250,000 board feet of lumber each, it is very probable that at least 100,000,000 feet of lumber will go into this class of wooden ships annually for the next few years. Its importance to the community is better understood when it is remembered that this will mean the spending of approximately $4,000,000 (£820,000) a year for lumber and about an equal amount for labor by this one industry.

The author is indebted to Mr. Martin C. Erismann, of Seattle, for helpful suggestions in the preparation of this article.

Steamer to be Built at Vera Cruz.—Manuel Angel Fernandez, of Vera Cruz, Mexico, is to begin building a steamer for cargo and passengers, said to be the largest built in Mexico. It is to have a single deck and is to be 130 feet long, 25 feet wide, and of 10-foot draft. The displacement is to be 200 tons net and 250 tons gross. The propelling machinery is to be an engine of the Diesel type of 200 horsepower.

WOODEN MOTORSHIP FOR WEST INDIA TRADE

Designed by Young, Rakestraw & Ferguson, Wilmington, Del.

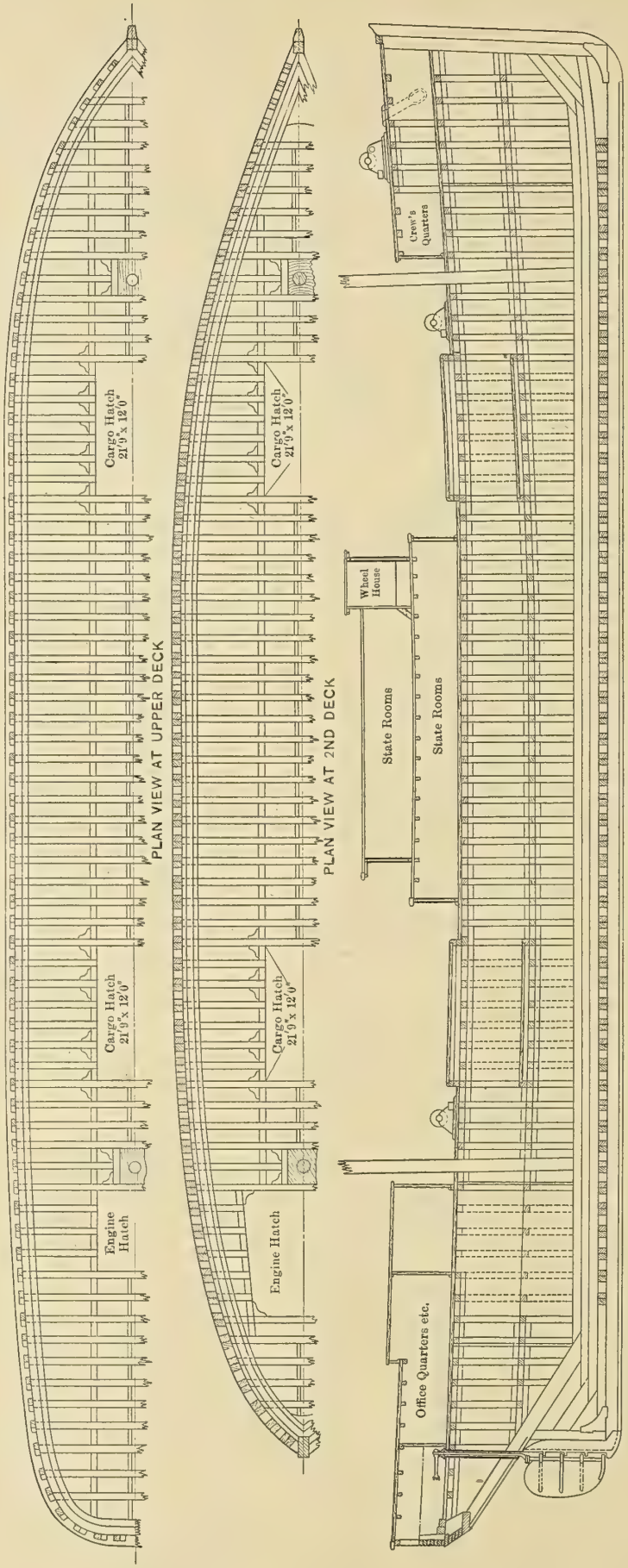


Fig. 1.—Decks Plans and Inboard Profile

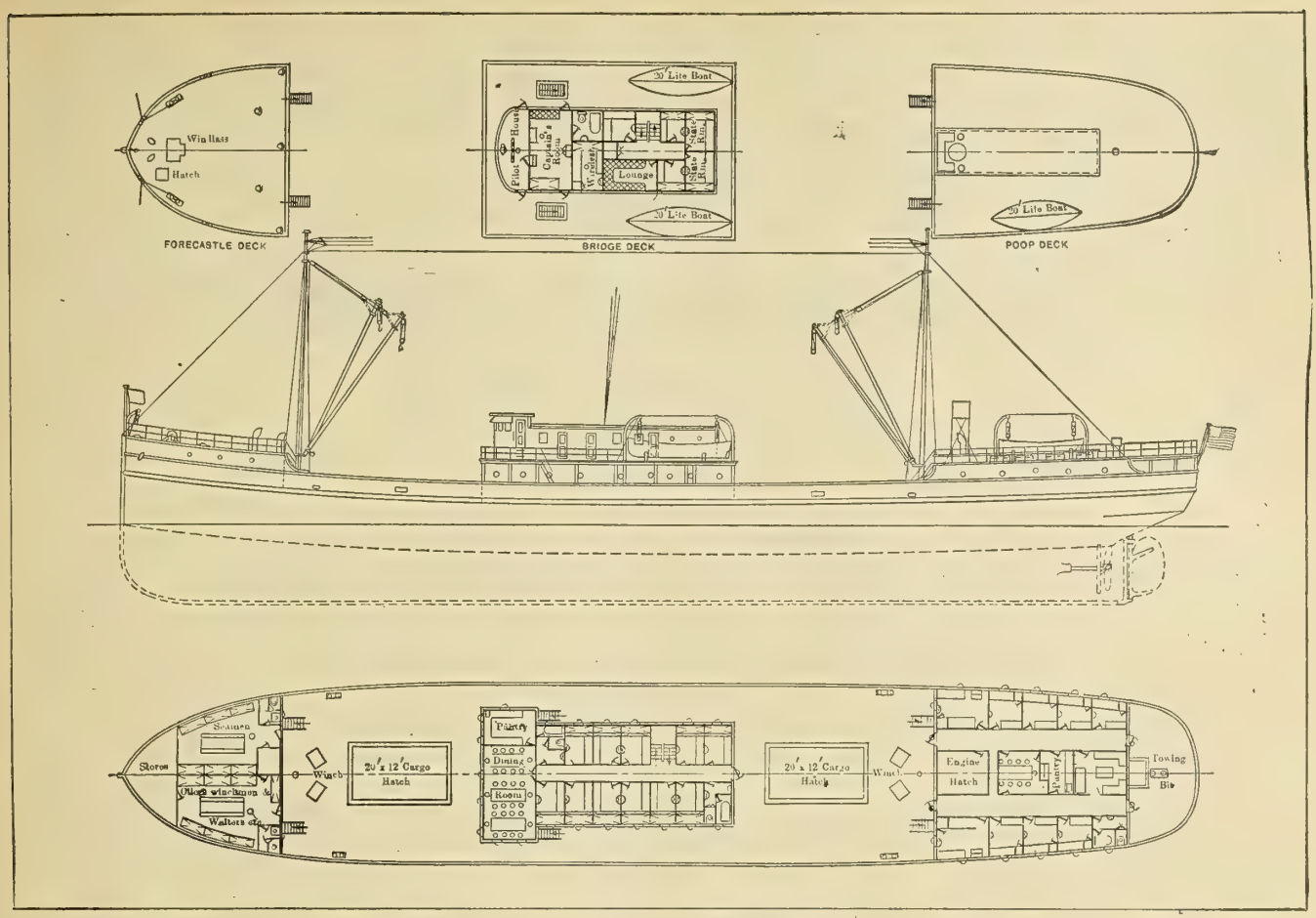


Fig. 2.—General Arrangement Plans

Wooden Motorship for West India Trade

The wooden motorship, shown in the accompanying plans, has been designed by Young, Rakestraw & Ferguson, naval architects, of Wilmington, Del., for the Haiti Trading Company, of New Orleans. The vessel is of the raised forecastle and poop deck type, designed to carry 1,850 tons of lumber and general cargo and about 30 passengers, with fuel and water for a seven-days' round trip to the West Indies. The ship is designed according to the rules of the American Bureau of Shipping and is to be constructed of wood throughout, 1,027,000 board feet of long-leaf yellow pine being required for the purpose.

The principal dimensions of the hull are:

Length	235 feet
Breadth, molded	42 feet
Breadth, extreme	43 feet
Depth, molded	23 feet
Draft	18 feet
Deadweight carrying capacity	1,850 tons

Propulsion is by twin screws actuated by Diesel-type engines of 1,250 indicated horsepower. Two fuel tanks of 7,000 gallons capacity and one fresh water tank of 1,500 gallons capacity are fitted in the forepeak under the upper deck and so arranged that when one is empty it may be used as a water ballast tank. A service tank of sufficient capacity for one day's run is located in the engine room, and is connected to the supply tanks in the forepeak by a pipe and pump line. The consumption of fuel oil per horsepower hour is estimated at .5 pound and of lubricating oil in the ratio of 1 gallon to 150 gallons of fuel oil. The grade of oil used in these engines can be obtained at approximately 2½ cents a gallon, depending upon the locality.

The auxiliary machinery consists of donkey boiler and dynamo located on the lower deck aft. There are two steam winches at each mast and large hatches are fitted for the quick handling of the lumber.

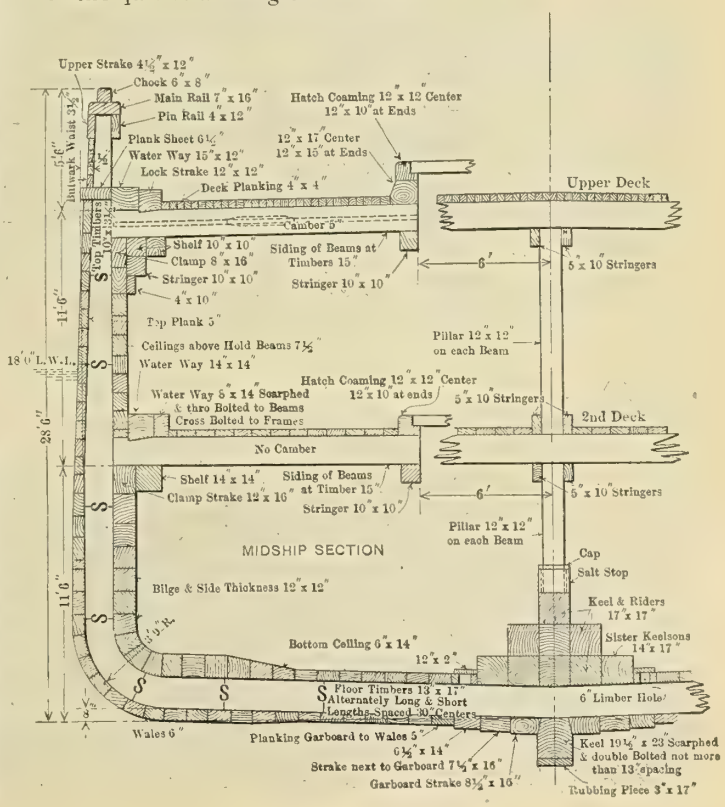


Fig. 3.—Midship Section

When designing the hull the naval architects at first decided to use a steel keelson throughout the length of the vessel in place of the present keelson and sister keelsons. Considerable weight and cargo space could have been saved in this manner, but as it is expected that the vessel will be built in the South all steel work has been eliminated. In place of beam knees, continuous clamps are fitted under each deck.

At the present time it is found that wooden motor vessels are considerably cheaper than similar vessels of steel, and much quicker delivery can be obtained for wooden construction than for steel vessels of similar size.

Wind Resistance of Ships

Results of Tests on Model in Wind Tunnel at Massachusetts Institute of Technology

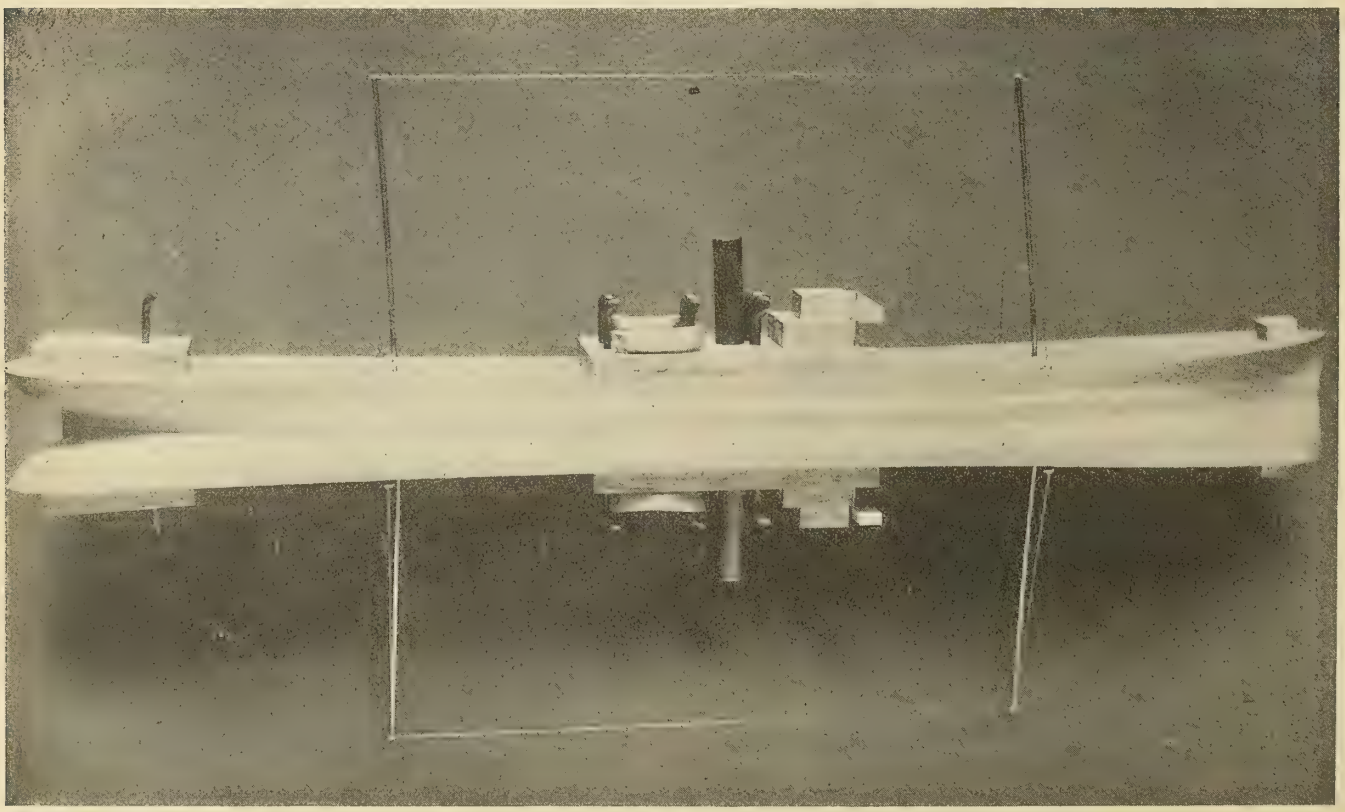
BY SHATSWELL OBER

EXPERIMENTS were made in the wind tunnel of the Massachusetts Institute of Technology, Boston, Mass., to determine the resistance caused by the pressure of the wind on the exposed parts of a merchant vessel. The ship selected was an ordinary cargo steamer, shelter-deck type. Its dimensions were: Length, 360 feet; beam, 46 feet; displacement, 3,270 tons at 23-foot draft. The steamer had a speed of 11 knots and an indicated horsepower of 1,990. The effective horsepower at 11 knots was estimated at 1,200.

The model was made to the scale of 1/16 inch equals 1 foot. This small size (25 inches overall) was necessary to avoid the possibility of interference by the walls of the tunnel and to avoid placing too much weight on the balance. The model was practically complete, except for rigging and minor details. It would not be possible on that scale to use anything that would be similar to the rigging of the ship. The resistance of the rigging, etc., was calculated from aeronautical tables on the resistance of wires, ropes and cylinders. The model was made double; just as if two similar ships were cut across at the waterlines and the above-water parts placed together. Thus the model was symmetrical, both about its centerline and "waterline." The upper works were made detachable, so that the relative resistance of the different parts could be found.

The total wind resistance when the speed of the wind relative to the ship was 26.06 knots (30 miles per hour), was 3,420 pounds. This was divided as follows: Hull alone, 27 percent; lower deck houses, 15 percent; upper works, including pilot house, bridge, stack, boats and ventilators, 31 percent; masts, 8 percent; rigging, etc., 19 percent.

At any speed and for any similar ship the resistance may be calculated by the formula $R = 0.0036\ A\ V^2$, in which R is the resistance in pounds, A the total projected area in square feet of all parts above water and V the speed of the air relative to the ship in knots. It is of in-



Double Model of Cargo Steamer Used to Determine Wind Resistance of Exposed Parts of Vessel

terest that, if a similar formula is formed for the hull alone, the constant instead of 0.0036 is only 0.0019. From his experiments with the *Greyhound* (Proceedings of the Institution of Naval Architects, Vol. XV) William Froude reports a similar formula, but gives for the constant 0.0048.

Of the total effective horsepower, 1.7 percent is used in calm air in overcoming wind resistance. This percent increases rapidly, if the ship runs into a wind. If the wind were dead ahead and 30 miles per hour absolute, 215 horsepower would be absorbed, or about 18 percent of the total. If the effective horsepower were constant and there were no increase in water resistance due to waves, there would be a loss of speed of somewhat over half a knot, or 5 percent. Actually, this loss would be greater.

Naval Constructor William McEntee reports (Transactions, Society of Naval Architects and Marine Engineers, 1916) the wind resistance of the United States collier *Neptune*, found by wind tunnel resistance on an exhibition model. He states that against a wind of 30 miles absolute the power absorbed would be about 20 percent of the total effective horsepower. A statement of the percent of power taken by the wind or the percent the wind resistance is of the total gives no basis for comparison or application to another ship; for such a statement makes the wind resistance depend on the size and shape of the under-water body of the ship. It does, however, give a general idea of the magnitude of the wind resistance.

Why Is Camber?

Old Mac, the Veteran Ship Draftsman, Shows "the Cubs" How to Lay Down the Camber of Deck Beams

CHARLEY ADAMS had been working for a week arranging gratings, etc., in the engine and boiler room. He had been after Old Mac several times to know the height of the coamings and different points on the beams. Mac would scale these points for him off the body plan. The last time he told Mac that he was a quarter of an inch higher on the same point than before. Mac gave him a hard look and asked him why he had put him to that trouble the second time. Charley said that he wanted to check him up and see how closely he was working.

Charley is no respecter of persons. To him everybody is alike. He had come into the office from the shop, where he had the reputation of being decidedly fresh. The story goes that on several occasions he had been roughly handled by some of the older men who would not put up with his disrespect. Mac looked him over again and quietly said that after this he could do his own scaling, and then if there was any variation he could have himself to blame.

Mac left him looking foolishly at the body plan. Charley monkeyed around for awhile and then quietly slipped over to his board. Some time later he told the chief that the hull side would not help him out and he guessed he was hung up with his job.

The chief asked Mac what the trouble was. Mac smiled and said that Charley was so particular that he had better wait until the beam mold and offsets came in from the loft and then he could get coaming heights as close as he wanted them.

"How close does he want them?" asked the chief.

"Well, he seemed to think that a quarter of an inch variation scaling that half-inch body plan was pretty coarse," said Mac.

"Huh!" exclaimed the chief, "he will be figuring press fits on the treads of those ladders next. Say, Mac, you had better add this one to your other two cubs and give the three of them a talk on camber. Getting these kids started right will save time in the end and may help us to put through that camber scheme of ours some day. Old Jerry certainly does ball us up and delays us every time he puts that mysterious camber of his into the ships he lays down in the loft. He will never use a slide rule, Mac; that is a sure thing. Round them up this afternoon some time."

"All right," said Mac, resignedly.

As the chief went to his desk he stopped at Charley's board and told him that Old Mac was going to give young Stevens and Tek a talk on camber after lunch and that he wanted him to get in on it. "Don't you be fresh again with Mac," warned the chief. "He is a good fellow and will be a good friend of yours, if you treat him right. Cut out this rough talk. If you persist in it, you will finish your time out in the blacksmith shop and that blonde girl of yours will give you the go by and walk home from church on Sundays with that tall thin fellow who works in the bank. What do you say?"

"I got you the first time, chief," replied Charley. "I am hip."

When Mac came in from the yard at noon the three cubs were on hand. Charley had posted the other two. Mac started in without ceremony, as follows:

"Camber is the curvature given a deck beam so that the deck is high at the center and slopes down at the sides of the ship. The idea is that the deck will shed water and drain to the sides. This may be of importance in the case of wooden and weather decks. A wooden deck rots if it does not drain properly. The classification societies require a round up or camber of a quarter of an inch per foot of beam. A steel deck does not rot and the ship is not always plum, so that camber here does not seem necessary.

"The idea that a cambered beam is stronger than a straight or level beam is wrong. Cambering does not increase the section modulus. A cambered beam is not an arch, because the sides of the ship are not abutments that will successfully resist a thrust. The stress line would lie away off the middle third, if there were not more curvature than camber gives. The Lord only knows what the load would be.

"The use of camber is often a waste of effort. Many decks would be better flat. The wooden shipbuilders handed this camber idea down to us and it may be some time before we can get rid of it. It is a nuisance. This wooden shipbuilder would lay it down secretly on the loft and contend that, due to the particular round up of beam and the shear that he used, his ship would sail faster

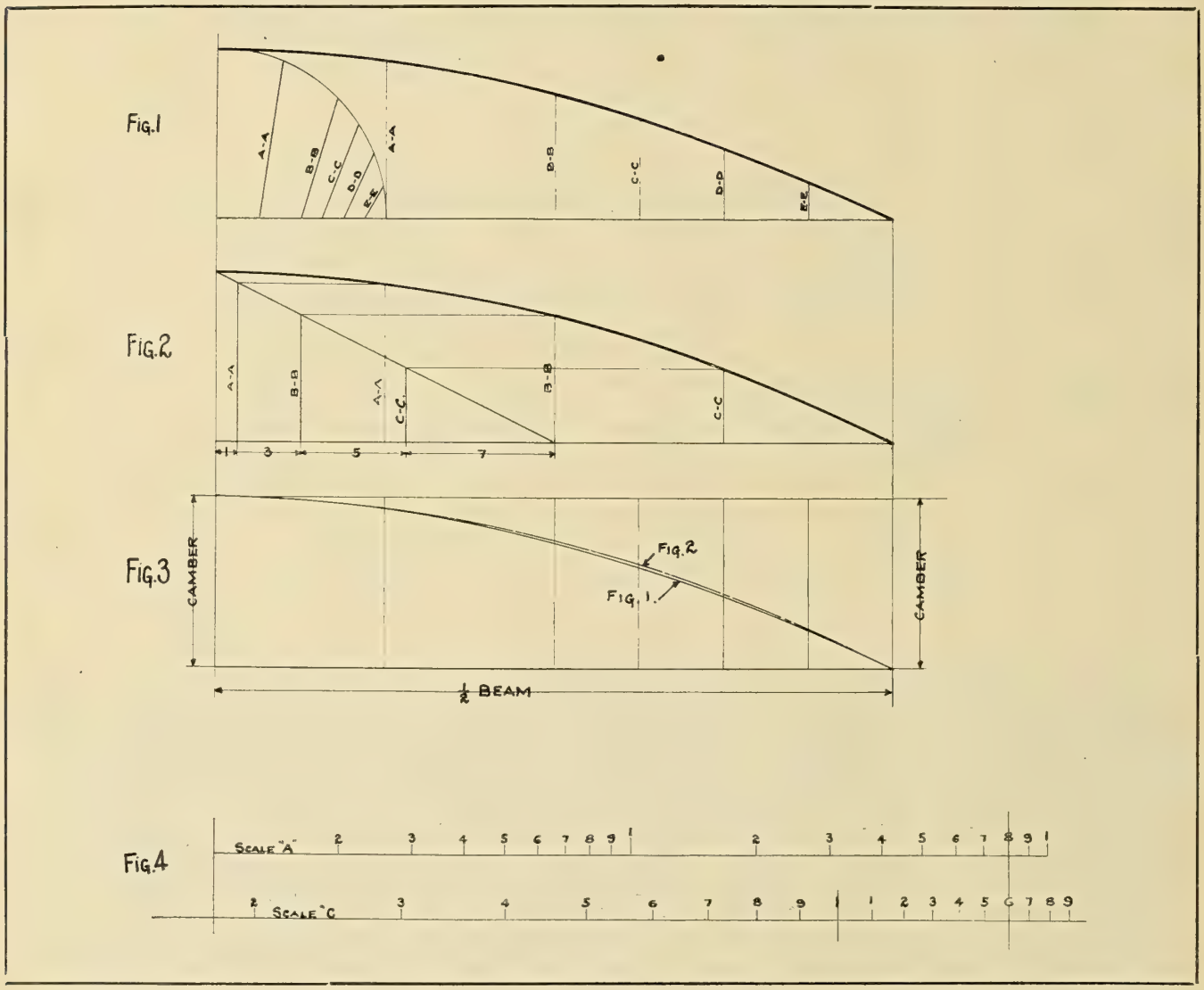
and closer to the wind than any ship yet built. She would be stronger and more stable—until he built the next one, then he had to improve the camber. Camber is with us though and you will have to know how to handle it, so I will tell you how it is laid down.

"One way is to draw a circle and divide the base and one quadrant like this (see Fig. 1). Connect the corresponding points. Set off these heights on corresponding points, using the half beam of the ship as base line, thus (see Fig. 1). A curve through these points will give the desired shape of the cambered beam. As the beam shortens as the ship narrows in, the lower or outboard end is cut off so the middle portion remains the same. *A-A, B-B* and *D-D* are the quarter points and *C-C* and *E-E* are just put in on the eighths to give more points and better define the curve. Do you understand this, Charley?"

"Yep, I get you," replied Charley.

"Another way," continued Mac, "is to set up at the quarter points of half the beam of the ship 1/16, 4/16 and 9/16 of the camber at the center. This is called the 1-3-5-7 rule, because an easy way to get these fractions of the camber is to lay down a base line of sixteen units in length, erect the camber at one end and join this point with the end of the base line (see Fig. 2). Perpendiculars erected at the one, three and five points will give the one, four and nine-sixteenths desired. A curve through these points gives another beam camber and probably the one most used.

"Now you see that if I lift the first curve and put the tracing cloth over the second one there is not much difference. The 1-3-5-7 curve is a little sharper and fuller, but not much (see Fig. 3). The flatter curve might be an advantage in a boat that has a lot of hatches at the center and whose deck beams are short and nearly flat at the side. Surely this small difference would not set the world afire, but there are some fellows who will want to fight if you don't favor their particular camber.



Methods of Laying Down the Camber

"Some people think there is another camber. Your slide rule friends swear by it, Tek, and if a slide rule is good for anything at all, maybe this is it. However, the slide rule camber is a parabola and the same parabola that the 1-3-5-7 rule gives. The apparent difference is that the ordinates of the 1-3-5-7 rule are laid up from the base line and the slide rule readings are laid off down from a base line (see Fig. 3).

"Now to work this slide rule camber you pick the camber in inches out on the upper or *A* scale of the rule. As all of your readings will be to the left you had better keep as far to the right as possible. Say, for example, the half beam is 16 feet. At a quarter of an inch per foot the camber would be eight inches. Well, let us take the eight near the end of the *A* scale (see Fig. 4). Set the

runner here. Now bring the sixteen on the *C* scale under the runner and you are set. For any other half breadth the camber can be read directly off the *A* scale. Of course when you pass the one or ten of the *C* scale, which is the ten-foot half breadth in this case, you have to shift the slide to the left so that half breadths less than ten come on the rule (see Fig. 4).

"Let us figure these fractions and lay them down from the top on to the 1-3-5-7 curve. Take the eight-foot outpoint, for instance. It is 2 inches even. The 1-3-5-7 rule gave us 6 inches even, remember? Two inches plus 6 inches is 8 inches, the total camber. Do you get me, Adams?"

"I got you," said Adams promptly.

"Now, the beauty of this slide rule camber method is that no graphical solution has to be depended upon. One man may lay down the camber graphically a little bit differently from another. With the graphical method one man has to lay it down and the rest of us have to use his work, and when we want a point on some odd half breadth we have to get him to scale it off for us. The personal element comes in here and makes a lot of trouble, especially when that person is a wild Irishman, whom you can't reach with a 10-foot pole. Jerry is certainly perpetuating the one-man rule in the loft. You see, if we could prevail on Old Jerry to use this slide rule method, then we could get the beam height at any point and at any time, because all slide rules are the same and Jerry could not help but lay down his beam mold as we would figure he would. We would not have to go near him. He don't know how to use a slide rule, won't learn and the higher-ups don't believe in experimenting during these rush times, so the slide rule method, although it is a good one, will have to wait until we can get around Jerry, or until some other yard makes an owner pay for this pioneering. The higher-ups say that it will cost us something to get it going right, and just as soon as we get to bragging pretty strong about it, all the other yards will adopt it, the price of ships will go down and then we will have had all our trouble for nothing.

"That gives me an idea. 'Old Man of the Sea' may be able to handle Old Jerry. They are cut out of the same cloth. 'Old Man of the Sea' would jump at the chance of teaching the game something new, and I think that it would be a good way to get him out of the office. Sick him onto Old Jerry, as it were, and let them go to it. Greek would meet Greek and we would win no matter how the cat jumped. Beat it, kids; here comes 'Old Man of the Sea.' Say, Adams, when you try that slide rule business the first time, be sure that you are not ten or a hundred feet off. Better get Tek to check you up."

"I am hip; I got you," replied Adams.

Later in the day Tek dug up his school books and looked up the equation for a parabola. $Y = a x^2$. In the case of the camber, curve Y is the ordinate down from the base and x is the distance out from the center of the ship. When x is equal to the half beam, Y is equal to the total camber, so that C = camber $= a \times l^2$ where l is the half beam of the ship. Therefore,

$$Y = \frac{C}{l^2} \times x^2.$$

For x equal to 1/4, 1/2 and 3/4 of the half beam Y would be equal to 1/16, 4/16 and 9/16 of C, or just what the 1-3-5-7 rule gives. Mac was right. Tek was satisfied.

Annual Meeting of the Institution of Naval Architects

The annual meeting of the Institution of Naval Architects was held in the hall of the Royal Society of Arts, John street, Adelphia, London, on March 28 and 29. Sessions were held in the morning, afternoon and evening of the 28th and in the morning and afternoon of the 29th. The programme was as follows:

Wednesday, March 28

1. Standardization as Applied to the Machinery for Cargo Boats. By D. B. Morison, member of Council.
2. On a Method of Obtaining for Ship Design the Spacing of Bulkheads According to the Rules of the International Convention. By W. J. Lovett, member.
3. Stress Determination in a Flat Plate. By James Montgomerie, B. Sc., member.
4. The Closing of All Ship Side Apertures from the Bridge. By Signor E. Benvenuti, member.
5. Description of an Apparatus for Interpreting Stability for the Use of Shipmasters. By Thomas Graham, associate member.
6. The Strength and Inner Structure of Mild Steel. By Professor W. E. Dalby, M. A., B. Sc., F. R. S., associate member of Council.
7. Design of Pin Joints Based on Ultimate Strength. By Lieut. W. A. Scoble, R. N. V. R.

Thursday, March 29

8. Further Experiments Upon Wake and Thrust Deduction Problems. By W. J. Luke, member of Council.
9. Some Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships. By J. J. King-Salter, R. C. N. C.
10. Theory of Wave Motion on Water. By Sir George Greenhill, M. A., F. R. S.
11. Marine Application of Reduction Gears of Floating Frame Type. By J. H. Macalpine, member.
12. On Launching. By P. A. Hillhouse, B. Sc., member of Council, and W. H. Riddlesworth, M. Sc., M. Eng.
13. Buoyancy and Stability of Submarines. By Professor W. Hovgaard, member.

New Concrete Shipways at Fore River Shipyard to Accommodate the Latest Type of Battle Cruisers

Following closely upon the heels of the announcement that the Fore River Shipbuilding Corporation, Quincy, Mass., had been awarded the contract to build one of the United States battle cruisers comes the decision to construct an entirely new set of ways to handle this great war vessel. Over $500,000 (£102,500) will be spent for the work.

To facilitate the erection of the ways the Massachusetts State officials condemned the necessary land, and the contractors, the Alberthaw Construction Company, Boston, Mass., have begun the surveying and soundings.

The new ways will be as large or larger than any in the world. They will be 990 feet long and will be fitted with electric cranes and overhead steel work embodying the most modern ideas for building vessels of all types. Even when one of the battle cruisers, which are the largest in the world, is lying on this set of ways, there will be 125 feet to spare in length, which may be taken to mean that the yard is preparing for a future growth in warships.

The heavy foundations supporting crib for keel blocks and launching ways are all to be of concrete. Over 12,000 cubic yards of concrete and 3,000 wooden piles will be required and approximately 3,000 tons of structural steel will be used in erecting the crane ways. These will be 870 feet long and will carry one 50-ton and three 7½-ton cranes, all of 120-feet span. The larger crane will run 121 feet above mean low water.

There has been little delay in getting to work and while the ways are being built the shop work on the cruiser will go ahead rapidly. The Alberthaw Construction Company plans to complete the ways, ready for the laying of the keel by September 1.

Fig. 1.—Stuart System of Handling Coal at the Curtis Bay Coal

New Baltimore & Ohio Coaling Pier

Maximum Capacity of New Coaling Pier at Curtis Bay Terminal 7,000 Tons per Hour—Two Units Installed on Single Pier

THE new $2,500,000 (£512,500) coal pier of the Baltimore & Ohio Railroad Company, which is now being operated at its Curtis Bay terminal, Baltimore, Md., is the first one of its type ever built, and once more that company becomes the pioneer in this important branch of freight transportation.

In 1914 the present facilities of the company had reached their maximum capacity, and the management decided to build a new coal pier. Before deciding on a type, however, the coal piers along the seaboard and abroad were considered, so that proposed new facilities would compare favorably with the best in existence, and while considering various schemes the engineering department originated one to handle coal by mechanical means.

The entire improvement was originated and designed complete by and under the direction of Mr. F. L. Stuart while he was chief engineer of the company, patents having been issued to him covering the main features of the same. Upon the resignation of Mr. Stuart from the Baltimore & Ohio last July the work was taken up and completed under the direction of his successor, Mr. R. N. Begien, the present chief of the company, and associated with him were W. S. Bouton, engineer of bridges; J. H. Davis, electrical engineer; M. A. Long, architect and assistant engineer; F. C. Thornley, consulting engineer, and J. T. Wilson, district engineer.

The contractors on the improvement were H. S. Kerbaugh, dredging; Phenix Construction Company, pier substructure; Smith & McCormack Company, excavation and foundations; Edward Brady & Sons, reinforced concrete bins; McMyler Interstate Bridge Company, car dumpers and tower structures; Robins Conveying Belt Company, conveying machinery; General Electric Company, control, motors and wiring; Westinghouse Electric & Manufacturing Company, sub-station, and Surety Engineering Company, coal thawing shed.

The Scheme in Detail

This scheme consists of two car dumpers and a concrete pier with its deck 8 feet above mean tide. On this pier are four loading towers and two trimming towers, to which the coal is delivered by belt conveyors from receiving hoppers at the car dumpers or from the balancing bin interposed between the dumpers and the pier. The installation consists of two units—one car dumper, two loading towers and one trimming tower making a unit.

Each car dumper is designed to handle sixty cars of 50 tons capacity each per hour, or forty cars of 100 tons capacity each per hour, and will handle a car 54 feet in length.

The tracks leading to the dumpers are on a descending grade, so that cars run to the barney pit by gravity. The

Pier of the Baltimore & Ohio Railroad Company, Baltimore, Md.

barney pushes the car up a 10 percent grade to the cradle of the car dumper. After the car is placed on the cradle it is clamped and turned upside down, delivering the coal onto a counter-weighted apron. This apron or pan can be raised when a car is to be dumped so as to minimize the drop of the coal from the car. When the car has been dumped the apron is lowered to an angle that permits the coal to slide freely from the apron to the belts that convey the coal to the vessel.

There are three belts to each car dumper, each belt being 60 inches in width, having a capacity of 2,000 tons per hour, running 500 feet per minute. Two in each group run out on the pier to a loading tower. The third runs to the balancing bin.

In order to run the plant to its maximum capacity the operation of the car dumpers must not be interfered with, and when it is necessary to stop a loading tower to shift it to another hatch the coal is placed in the balancing bin temporarily. From this bin the coal is taken by either a loading tower or trimming tower and placed into the vessel.

The Loading Towers

The loading towers are each equipped with a cage supporting a shuttle ram. The cage is raised and lowered to suit the height of the vessel being loaded. It has a variation in height of 27 feet, the minimum height above the water being 15 feet. The shuttle ram can be run out on either side of the pier; its maximum reach from the face of the pier being 45 feet.

As the towers travel up and down the pier in a horizontal plane and the shuttle works in and out at right angles to the travel of the towers, it can readily be seen that this apparatus will load a hatch uniformly and reduce trimming to a minimum.

The two trimming towers (one on each side of the pier) have belts 48 inches in width, with a capacity of 1,500 tons per hour, running 500 feet per minute. Coal for these belts is taken from the balancing bins. These towers have swinging booms 45 feet long. They are attached at their base to turntables and can be moved in a circle on a horizontal plane and have a vertical variation of 35 degrees each way from the horizontal.

While the loading towers are working on the cargo the trimming towers are loading the bunker coal. After the loading towers have finished loading the cargo (except the trimming) the trimming tower finishes the slow work on the vessel, the loading towers being free to work on another vessel.

The various functions are interlocked and controlled electrically with push-buttons located every 20 feet on each belt conveyor runway. By pushing a button all movable parts of the belts, tower and feeders are stopped.

The operators are located in houses on the shuttles. From their houses they start first the shuttle belt; when this is running at full speed the main belt automatically starts, and when at full speed the feeders start automatically. The shuttle belt runs at a greater speed than the main belt, and the main belt runs faster than the feeders, so that there is no danger of flooding the main of shuttle belts. There is a master control in the superintendent's office, so that he can establish the maximum speed at which the belts can be run.

The Pier Capacity

The pier will not only have the greatest capacity of any pier in existence, but will handle coal with a minimum amount of breakage. On the loading towers a lowerator will be attached when gas (lump) coal is being handled.

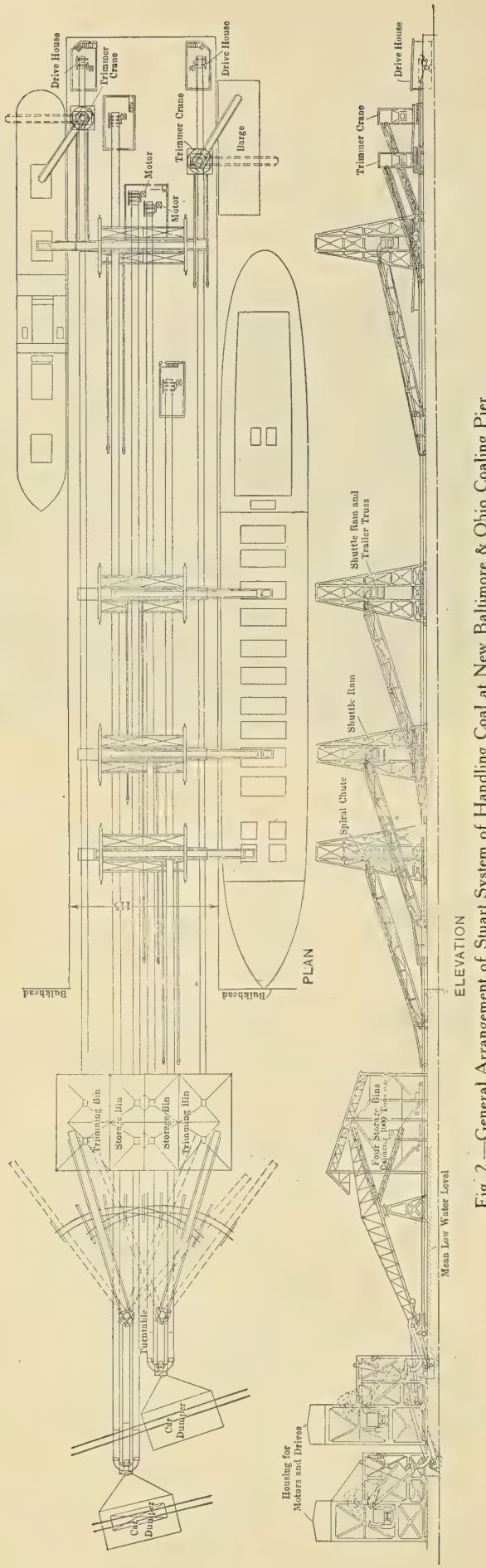


Fig. 2.—General Arrangement of Stuart System of Handling Coal at New Baltimore & Ohio Coaling Pier

The lowerator carries the coal into the vessel and deposits it with a maximum drop of about 3 feet.

The pier is of reinforced concrete dock and girders supported on concrete piles. The mechanism on the pier is all of steel construction, so that the entire pier is built of fireproof material. The old facilities are entirely of wood construction.

Two tracks leading to the car dumpers are covered by a steel and concrete thawing shed of 22 cars capacity, into which cars are placed for thawing in severe winter weather. Experience shows that cars placed in this house

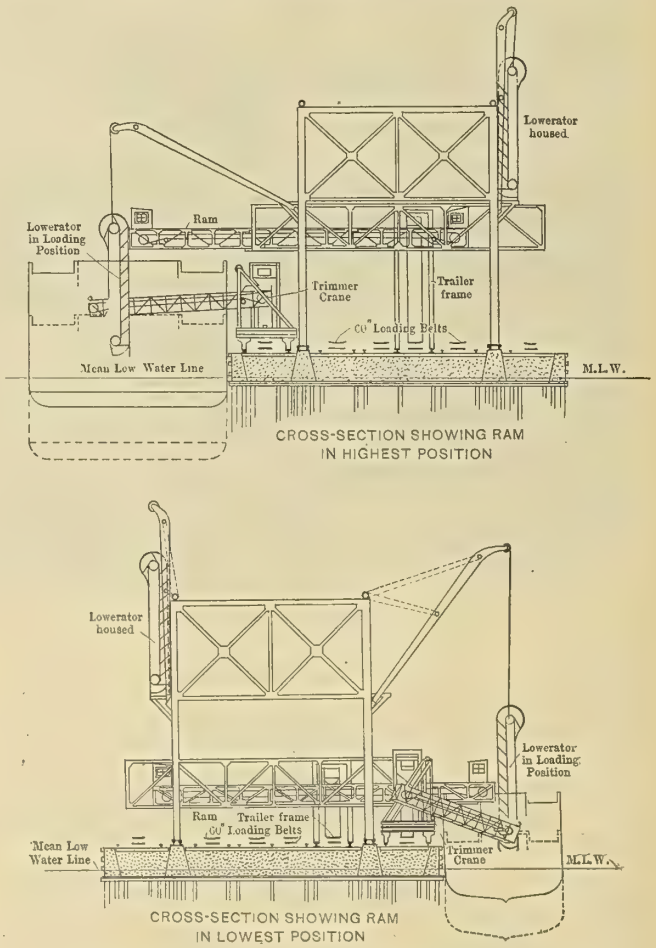


Fig. 3.—Sections of Pier Showing Operation of Ram

for thirty minutes, at a temperature of 180 degrees, are thawed sufficiently for the coal to free itself.

All functions are operated by electric power, except the car dumpers and the thawing shed. These are operated by steam.

It was necessary to dredge a channel into the new pier, as well as the slip on each side. Four hundred and fifty thousand yards of sand and clay were dredged and used to build the yard. This was done by suction dredge and pumped to a maximum height of 30 feet.

Advantages of System

The pier has many advantages: (1) It will have a greater capacity than any other in existence; (2) it will handle lump coal with a minimum amount of breakage; (3) it is fireproof; (4) it will permit of the unloading of any type of open car with ease and dispatch; (5) it will be the means of attracting a great deal of business to the port of Baltimore; (6) it will improve the coal car supply.

Actual work was commenced in February, 1916. The first half of the pier was put into service January 15, 1917.

Considering the magnitude of the work, the amount of special machinery necessary and the condition of the material market, the record for speed was remarkable.

Capacities of the Old and New Piers

The maximum capacity of old piers was 2,500 tons per hour when loading into the type of boats similar to those owned by the Federal Coal Company. The average working capacity of old piers was 1,250 tons per hour.

The maximum capacity of the new piers is 7,000 tons per hour, with both dumpers working (2,500 tons per hour per dumper, with trimmers handling 1,000 tons per hour each from the balancing bins). The average working capacity of new pier is 4,000 tons per hour.

The speed of delivery of coal from barney to hold of vessel is 8 cars in 21 minutes, or 2.6 minutes per car by test (one belt working); 16 cars in 21 minutes, or 1.25 minutes per car by test (two belts working). In recent operations a car has been dumped in a minute.

One car dumper will feed two belts. It is expected to dump 45 cars per hour per dumper, or 90 cars per hour, or 5,000 tons per hour. Two thousand additional tons per hour will be handled by the trimmers from the bins, making ultimate capacity 7,000 tons per hour.

The Terminal Shed and Warehouse—II*

BY H. MC L. HARDING†

Wooden sheds and wooden piles substructures above the water's level, which may be swept away by fire, both shed and substructure, in an hour, along the whole terminal frontage, and leave only the blackened tops of the piles just above the water, thereby stopping all waterborne commerce for months, should not be permitted, any more than wooden buildings within the fire limits of a large city.

The three characteristics of substructures should be fireproof, rat proof and decay resisting.

The following figures as to the initial investment, based on cubic contents of the modern steel sheds, on quays, with 30 feet inside clearance, 500 feet long and 80 feet wide, in comparison to the usual type of wooden shed with 15 feet clearance, may reveal facts and truths not generally accepted.

It is desired to hold in the shed about 800,000 cubic feet of merchandise. As has been shown, this can be stored in a steel shed 500 feet long, 80 feet wide, and tiering 20 feet high by overhead traveling cranes with adjustable loops. At 3½ cents per cubic foot, the investment for this steel would be $42,000 (£8,600), and the gross floor space would be 500 feet by 80 feet, or 40,000 square feet. The investment per cubic foot for a wooden shed would average $0.0246. This is where lumber is exceedingly cheap.

Tiering 5 feet high instead of 20 feet, the floor area would be 160,000 square feet and the cubic contents 3,200,000 cubic feet, and the investment $78,720 (£16,120). This is for a wooden shed against $42,000 (£8,600) for a steel shed of equal capacity. That is, to store 800,000 cubic feet of freight, there would be in the wooden shed 160,000 square feet of floor space and of roof, against 40,000 square feet with the steel construction. The wooden shed would not be satisfactory for the internal assorting, distributing and tiering machinery. If these three necessary movements are performed by manual labor, the operating costs would be tripled. Floor space should not be reserved for mechanical appliances when overhead unoccupied space can be used.

In addition to the above, the cost of the land for the shed alone would be four times as much, and at $15,000 (£3,075) only per acre the cost for the additional land would be $45,000 (£9,225) more, than where the steel shed is adopted.

The above figures are comparative only, but prove conclusively that it is more economical even where lumber is cheapest and steel the highest, to construct at a modern terminal the shed of steel rather than of wood, where large tonnages are to be handled. The capacity of modern freighters is continually being increased and 1,000,000 or more cubic feet would more than likely be required than 800,000 cubic feet.

The principle of not having railway tracks within the shed, but outside, is of great import. Two or four railway tracks within the shed would occupy so much cubic foot space, that to have the same holding capacity as 800,000 cubic feet would add greatly to the cost of the shed, whether of steel or wooden construction.

In certain steel sheds lately constructed there were sixteen or more railroad tracks within these freight sheds. It is estimated that the cubic space reserved for the cars on these tracks added at least $80,000 (£16,400) to the cost of the sheds.

These and other examples are not given for criticism, but to make evident the need of terminal principles.

The following figures as to wooden shed costs are given as guides of low costs of wooden sheds and the costs of some of the accessories. The cost of the building includes that of the roof, etc. When on a pier or wooden structure the floor cost is charged to the substructure. The average increase at date should be about 10 percent. These figures are from Seattle, Wash.

Example 1.—Two-story shed, 20 feet by 800 feet:

Superstructure	Cubic Foot Contents
a. Building	$0.0366
b. Office and toilets	0.0014
c. Water supply	0.0008
d. Sprinkler system	0.0054
e. Electric wiring	0.0027
f. Paving	0.0010
g. Elevator	0.0062
h. Roofing	0.0009
Per cubic foot	$0.0550

Example 2.—One-story wooden shed, 90 feet by 330 feet:

Superstructure	Cubic Foot Contents
a. Building	$0.0185
b. Offices and toilet	0.0005
c. Water supply	0.0005
d. Sprinkler system	0.0036
e. Electric lights	0.0009
f. Roofing	0.0010
Per cubic foot	$0.0250

Example 3.—One and two stories, mostly one story, the gross area being 166,200 square feet:

Superstructure	Cubic Foot Contents
a. Building	$0.0232
b. Office and toilets	0.0006
c. Sprinkler system and water supply	0.0043
d. Electric lights and wiring	0.0011
e. Paving	0.0005
f. Roofing	0.0009
Per cubic foot	$0.0306

* Concluded from the April issue.

† Designing Terminal Engineer, New York, N. Y.

Example 4.—One story, two buildings. Two U-shaped buildings, each arm of the U being 600 feet in length and about 97 feet in width:

Superstructure	Cubic Foot Contents
a. Building	0.0170
b. Offices and toilets	0.0005
c. Water supply	0.0008
d. Sprinkler system	0.0020
e. Electric lights	0.0007
f. Roofing	0.0010
Per cubic foot	$0.0220

Warehouse Costs

The cost of the concrete warehouse will also vary according to location, building laws and other conditions. In general, the cost of the building of four or six stories for miscellaneous goods will vary between 11 and 12 cents per cubic foot. Ten cents was a safe outside figure for a six-story terminal warehouse building three years ago.

In a concrete warehouse of three floors the following figures may be of service:

Item	Cost Per Cubic Foot
Concrete building	$0.1133
Elevators	0.0109
Electric light and power, wires and fixtures	0.0026
Plumbing and heating	0.0009
Sprinkler system	0.0057
Mastic roofing	0.0024
Per cubic foot	$0.1358

In this particular concrete warehouse for three floors the cost per square foot of gross storage is $2.343. The cost per ton storage, net, $9.716.

The cold storage portion of a warehouse, three stories, was per cubic foot:

Item	Cost Per Cubic Foot
Building	$0.1053
Elevators	0.0141
Plumbing, etc.	0.0023
Sprinkler system	0.0068
Electric light and power	0.0133
Mastic floor and roof	0.0131
Refrigerating equipment	0.0632
Insulation	0.0480
Well, pit	0.0105
Per cubic foot	$0.2766
Office, one floor, per cubic foot	$0.2488

Another concrete warehouse with electric light and power, sprinkler system, elevated tank, roofing, freight elevators, chutes, conveyor, scales, was $0.1069 per cubic foot.

Fruit Storage Warehouse

The cost per cubic foot of a fruit storage warehouse without refrigeration equipment was $0.1081 per cubic foot.

The Grain Elevator—Data and Costs

A grain elevator is practically a grain storage warehouse with the necessary machinery for unloading cars or vessels into this warehouse, elevating the grain and discharging it into ships, barges, cars or drays. There are also included other mechanical appliances for separating, cleaning, sacking and weighing the grain. The following data and costs of an elevator of a capacity of 500,000 bushels are of value.

The building is of reinforced concrete and consists of 25 circular bins of 15,000 bushels each, 16 interspace bins of 3,600 bushels each, and 25 workhouse bins. Height of storage annex, 83 feet. Height of workhouse, 165 feet. Bulk receiving capacity per day of twenty-four hours, 95 cars. Bulk shipping capacity per hour, 20,000 bushels.

Machinery of modern type driven by electricity.

The principal equipment consists of the following:

Three separators, or cleaners, capacity, each, 3,500 bushels per hour.

Two smutters, capacity, each, 500 bushels per hour.

Two receiving scales.

Two sacking scales.

Two shipping scales.

Two sack grain conveyors.

Two receiving legs, capacity, 6,000 bushels per hour, each.

Two shipping legs, 10,000 bushels per hour, each.

The cost of the elevator is, roundly, as follows:

Foundation	$26,500
Elevator contract	197,900
Cement	15,000
Bulk shipping conveyors	30,000
Miscellaneous other equipment	7,000
Tracks	9,000
	$285,400

The elevator is operated directly by the Port Commission under the State Terminal Warehouse law, which requires State supervision, weighing, grading and registered warehouse receipts. The owner controls the grain absolutely until sold by him. The port has no other interest than to provide the facility and the best possible service at practically actual cost.

Conclusions

1. The water frontage should be used only for those functions which pertain to quick transference of freight and cargo between vessel and shore.

2. Warehouses should be set back from the water frontage.

3. Sheds should be of steel and warehouses of reinforced concrete.

4. Sheds parallel to the berthing frontage should be set back from the water's edge about forty feet.

5. Tracks should be in front of the shed between the shed and the edge of the pier and behind the shed between the shed and the warehouse.

6. The top of the rails should be flush with the pavement.

7. The warehouse should be parallel to the shed and of the same height.

8. Tracks should be spanned by gantry cranes.

9. Assorting, distributing and tiering within the sheds should be done by overhead traveling adjustable loop cranes which operate in unoccupied air spaces.

New Office of Marine Engineering in London

In order to be prepared to handle our business to the best advantage when peace is restored, and to do all we can to further the best interests of our allies, the London office of Marine Engineering has been greatly expanded. Mr. E. J. P. Benn, Director of the English edition, has made preparations to meet any contingency. The capital of Messrs. Benn Bros, Ltd., has been increased to $487,000 (£100,000). The enlarged company has taken over a number of publications and moved to a large suite of rooms, 6 and 8 Bouverie street, E. C. This is in the heart of the publishing center of London. In the new quarters we shall be able to carry on the business of Marine Engineering with the greatest of economy and efficiency, and, what will be extremely important when peace returns, will be the opportunity to provide employment for something like 300 men when the army has done with them.

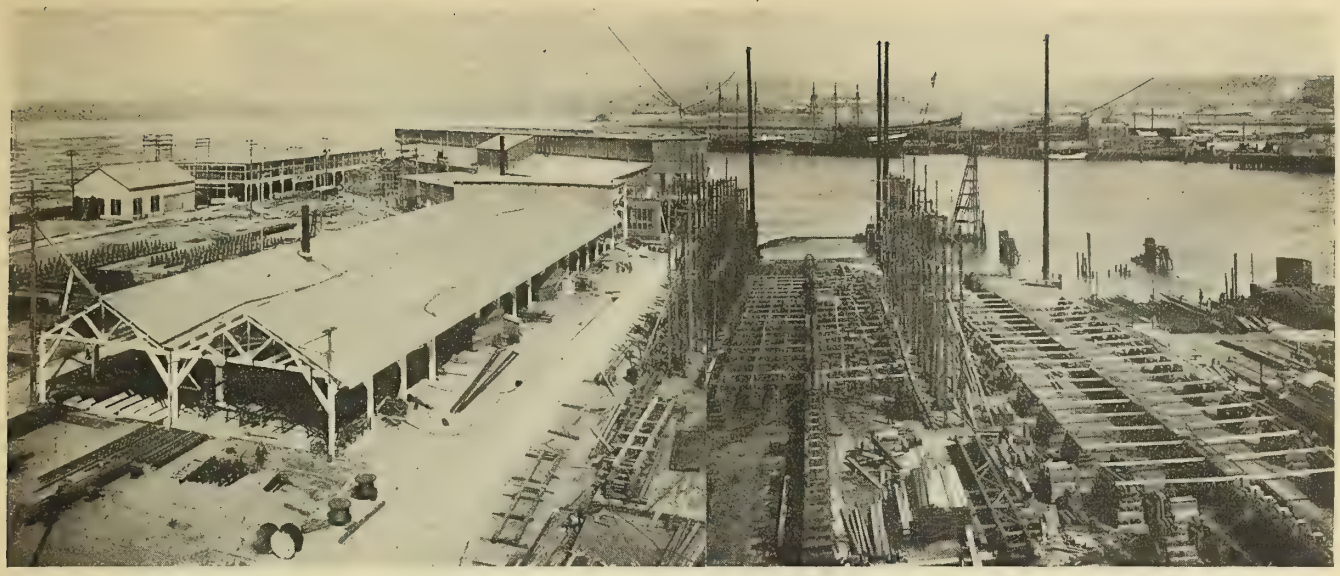


Fig. 1.—Panoramic View of New Ames Shipyard in Seattle

Ames Shipbuilding & Dry Dock Company

New Steel Shipbuilding Yard Established at Seattle—Plant Covers Seventeen Acres—Four Shipways and a Dry Dock Provided

BY GILBERT C. DOHM

THE ever-increasing demand for shipbuilding in the Northwest has made the Elliott Bay section of Puget Sound the leading shipbuilding center of the Pacific Coast. The Elliott Bay District has now four steel shipbuilding yards, which have been built with the evident idea of permanent establishment. These are the Seattle Construction & Dry Dock Company, the Skinner & Eddy Corporation, both previously described in issues of this periodical, J. F. Duthie & Company and Ames Shipbuilding & Dry Dock Company.

Built on a portion of what was once the Tide Land Section of Seattle, the new Ames shipbuilding yard is being developed on an even more elaborate scale than many of the other Pacific Coast yards. It is situated on West

Fig. 2.—Interior of Mold Loft, showing Lines of 8,800-Ton Deadweight Cargo Steamer

AMES SHIPBUILDING AND DRY DOCK COMPANY, SEATTLE, WASH.

Latest Addition to Steel Shipbuilding Facilities in Puget Sound

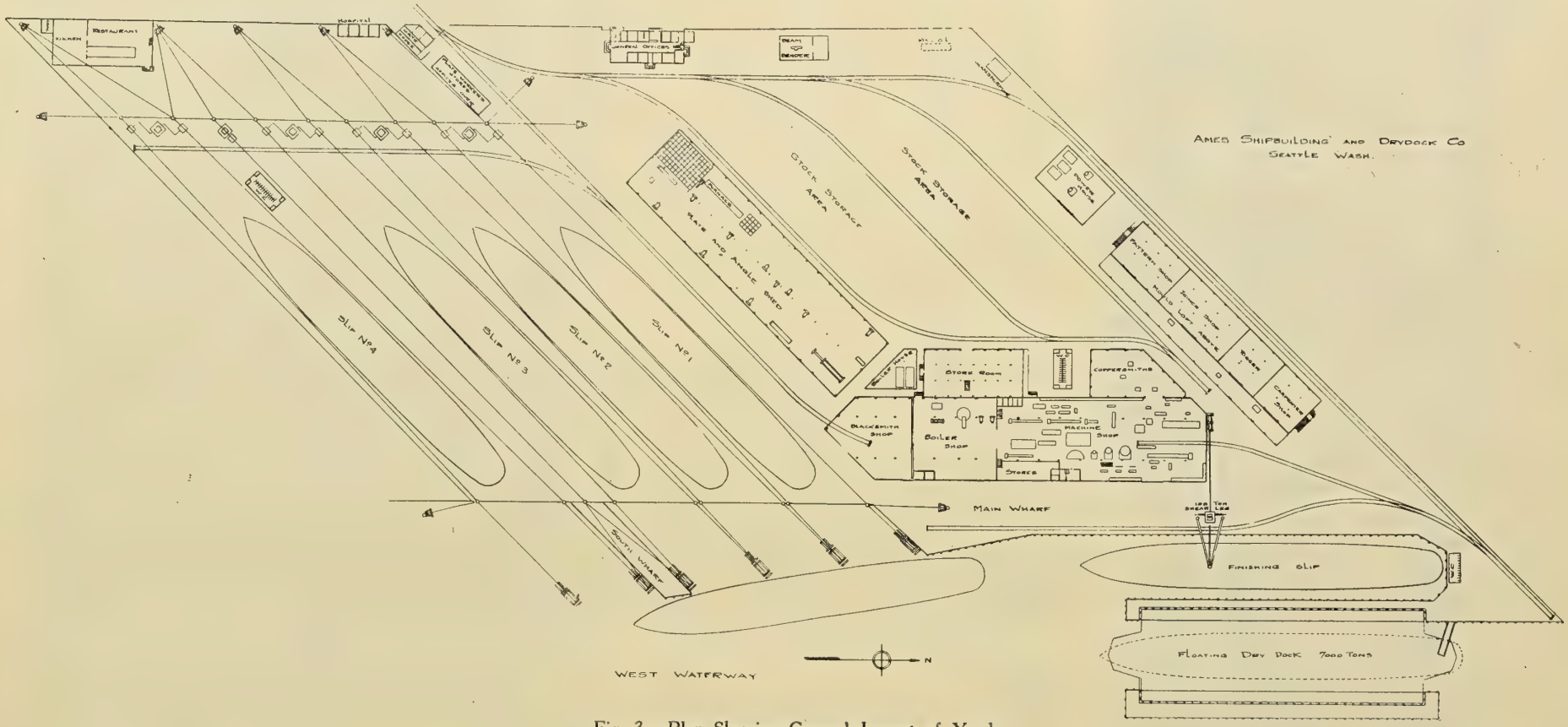


Fig. 3.—Plan Showing General Layout of Yard

AMES SHIPBUILDING AND DRY DOCK COMPANY

New Puget Sound Shipyard Located at Seattle

Fig. 4.—Pattern and Joiner Shop

Fig. 5.—Portion of Plate and Angle Shop

Waterway, where an unobstructed fairway leads into Elliott Bay, and is only a short distance from Seattle's busy waterfront and commercial center. This yard covers approximately seventeen acres and is directly connected with the main transcontinental railroads, which makes its location ideal for the handling of large work.

Preparations for the building of this plant were made late last year, the work having progressed so smoothly and rapidly that the company was enabled to lay the keels of two ships in March.

Construction of Buildings

The buildings are all of heavy mill construction, well braced and made up of sizes sufficiently great to withstand the shocks from the overhead traveling cranes, the radial cranes which serve individual machines, and the large overhead cranes which in the machine shop, boiler shop and blacksmith shop extend the total width of the building, and have a large carrying capacity. On account of this timber construction, efficient methods of fire prevention and control were immediately installed.

The layout of this plant is shown in Fig. 3. Much of the open space is used at present for the storage of plates and shapes, which material is now constantly arriving. A large space between the conveyor winches and the stem of the ships has been set aside for the storage of structures and parts built up or bent into shape beforehand, such as floors, frames, shaft alley framing, beams and brackets, etc.; and awaiting to be installed on their respective ships.

The power house, which is the source of all energy for the yard, is equipped with four Ingersoll-Rand compressors of 5,000 cubic feet capacity, which supply the compressed air for the drills, riveting and reaming machines, and bull riveters. These compressors are driven by Westinghouse motors. Steam for use in the blacksmith shop, plate and angle shop, yard heating system, winches, etc., is received from a 150 horsepower boiler, which is separate from the compressor house. As a large hydraulic press will be used for bending the plates, only angle furnaces were installed, and these are all fired by fuel oil. The plate and angle shop is fully equipped with planers, portable reamers, shears, rolls, drills, punching machines, etc.

Mold Loft

The mold loft is located above the pattern shop, joiner shop, riggers' shop and carpenter shop, and has now laid upon its floor the lines of an 8,800 ton deadweight cargo steamer, the keel of which is already laid. The floor is painted gray, which offers a much more pleasing color to work by than the generally used black. The walls of most of the buildings are glass paneled, which gives adequate light at all times.

The blacksmith shop, boiler shop, and machine shop are all under one roof and are connected by the same set of crane tracks, which run the full length of the building, thereby enabling material to be conveyed from one part of the building to another without first transferring. All the machinery and boilers to be used in the building of the ships will be constructed by the company.

Adjacent to the machine shop is the fitting-out wharf, 800 feet long by 60 feet wide, and at the end of the machine shop is a 100-ton shear leg. The finishing slip is located alongside of the wharf, and on the other side of the slip will be located a 7,000-ton dry dock and outer wharf.

The method of conveying material to the ships is accomplished by a system of aerial tramways, a system which is being used to a great extent in the Northwest. A unique feature of this particular yard is, however, the fact that the men operating the hoisting winches for each ship are located at the forward end of the slip in an operator's house elevated about 70 feet in the air. Two operators are stationed in each house, and in this way can communicate with one another when hoisting or lowering the material. The panoramic picture of this yard shown in Fig. 1 was taken from one of these houses and gives a good idea of the unobstructed view which the operators have, which enables them to do away with the bell signal system. The winches themselves are placed on the ground.

The hospital, which is divided into three sections, is entirely of white enameled finish and contains three beds, sterilizing apparatus, and operating tables, and is up-to-date in every respect.

A restaurant is being constructed by the company, as the plant is too far distant from the main part of town to permit the men traveling this distance at noon time. This restaurant will be be conducted by the company and a nominal charge for meals will be made. It is a two-story building with a large, spacious kitchen, and will accommodate approximately 250 men.

Two building slips are now completed and two more are now under construction. The company employs about 2,000 men and is working three shifts.

The officers of this company are Edgar Ames, president; David Hollywood, general manager; George W. Albin, secretary, and J. V. Patterson, consulting engineer.

Maritime Congress Proposed to Aid in Upbuilding the American Merchant Marine

While practically every great industry in the United States is indirectly interested in the building up of an American merchant marine, those directly, vitally and understandingly involved are the shipowner, the shipbuilder and the shipper. In all of the attempts which have been made in each succeeding administration to secure legislation fostering the American merchant marine and its allied industries there has been no co-ordinated effort on the part of the industries most vitally interested to bring about results. If a well organized body representing the interests of shipowners, shipbuilders and shippers, acting together, should form a coalition and work definitely for the upbuilding of the American merchant marine, there can be little doubt that many desired results could be brought about.

No more favorable time for the cementing of interests depending upon ocean transportation could be chosen than the present. The demands for ocean tonnage (never more urgent), due to the enormous growth of foreign trade by producers, manufacturers and shippers in the United States during the past two years, make it imperative that adequate provision be made for carrying on this commerce economically and efficiently in American ships.

With these needs facing the country, influential steamship and shipping men have suggested the formation of a maritime congress made up of delegates representing the interests most vitally involved in an American merchant marine. Such an organization could hold its conventions in some central location and could formulate an American maritime policy which would be authoritative and effective in influencing the public, and, in turn, Congress, toward the enactment of the necessary legislation for upbuilding an American merchant marine commensurate with the wealth, dignity and needs of a great nation.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

On Watch

What sort of use do you make of the time on watch? The natural answer would be, "I look after things and carry out the various duties of the watch." That's good; but do you make any mental progress when things are running smoothly and require but routine attention?

It is surprising how few of us make use of these moments to polish up the rust spots when the old engine is throbbing merrily along. The writer formed the habit of looking for things that could happen and mentally planning what he would do if such and such a thing happened and of thinking about improvements in different parts of the plant. Would one get more heat in the feed water by retaining a small amount of condensate in the lower part of the feed heater, or would it be more economical to let the exhaust steam pass right through?

Thoughts of this kind led to a number of practical experiments during many of my watches. It is surprising to note the endless number of things that are available in the plant to keep one's thinker busy, if he be so inclined. And Gee! how it makes the minutes slip by! Seeing into things, imaginative breakdowns, and what to do to correct them—this is a valuable trait. It puts new interest in your work and need not take your direct attention from your watch duties. The habit must be cultivated, and if your heart is in the profession you are following it does not take much effort. Many a time when an emergency came up the writer has been well repaid for the moments of inventive thinking when on watch.

I met a fellow who was serving in the capacity of first assistant, and has been for the past six years, yet he was the possessor of unlimited tonnage license in chief's grade. He said he had never got a show to use his chief's ticket. A little observation and quizzing soon told me why. He was waiting for an opportunity, he said. Now, as I have been through the mill, I know that he will keep on waiting, for opportunity doesn't knock loud enough for his kind to hear it. He will undoubtedly remain in the billet of first assistant until he gets busy and hunts for the opportunity and quits being satisfied as a first assistant.

I gleaned the facts from his chief; he told me that he was a good enough man for a chief's billet, if he only used his brains more often. "The trouble is that he wants me to do his thinking and planning and he is not observant when on watch. He never can anticipate a source of trouble, or invent a means of prevention, and whenever I drop down in the engine room on his watch, I find him sitting down, sort of dreaming. All notes of future repairs, or correction of poor conditions, come from the others and he remains content to let them find them."

What puzzled the writer after hearing this was how such a man obtained a ticket of the class that I have mentioned he possessed. Yet, after all, a license to operate does not imply that the holder will make a fit man for the position of chief engineer, for almost anyone who will spend time enough in poring over a few marine engineering text books and indicator catechisms of the usual question-and-answer type, can obtain a ticket; most especially if he be fortunate enough to get questions along the same lines he has read.

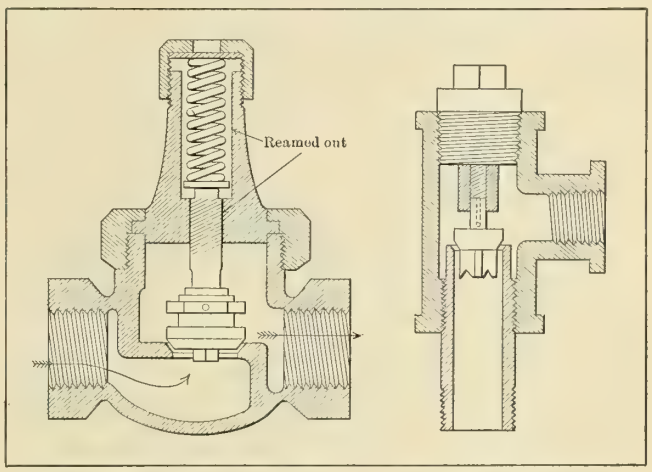
Such a fellow could pass a fair examination and obtain a percentage high enough to entitle him to a ticket but still be lacking in the essential qualities that go to make a good engineer. One who for six years or more remains at a standstill should pick himself to pieces and find out what is wrong. There will be many good chiefs in demand for the merchant tonnage now being built and the men to fill the billets will be thinkers.

PROGRESSIVE ENGINEER.

Kinks

While serving as junior engineer on board of a tramp steamer I picked up a few kinks. The sketches show a couple of improvised fittings that were made for use in the installation of a forced lubrication system for the main circulating engine.

In tropical climates it was necessary to run the circulating pump nearly full speed and to lubricate it sufficiently



Relief Valve Improvised from Old Globe Valve

Check Valve Improvised from a Tee

to keep things cool. With hand oilers or a drip feed system this was not only very difficult but called for considerable extra attention and waste of oil, so the chief decided to fit things up for forced lubrication. As we were to lie in Jolo, Philippine Islands, for a week, we started the job.

As we progressed we were obliged to improvise many things, among which were a couple of check valves and a relief valve. The material came from a bin of old fittings in the storeroom. The sketches are self-explanatory, so nothing will be said of them except that there is some lathe work involved. The relief valve was required to raise or lift at 10-pounds pressure, and the spring was made of ⅛-inch steel wire. The size of the valve used was 1 inch.

These are not economy kinks. We would have been able to purchase the fittings cheaper than we could have made them, but we could not get them in the port where we were located. They might be handy to some fellow in the same fix.

JUNIOR ENGINEER.

Keep Posted

Did someone to you a question ask
About certain features of his task?
Or something or other about the plant
To which the answer you couldn't grant?
Now, didn't it make you feel quite cheap
To think that your brain was part asleep?

How queer it does make a fellow feel,
When he can't answer right off the reel,
And finds he has to study a bit,
So that his brain may be better fit
To answer questions his men might ask
Of any details in daily task.

You had better study, engineer,
You must not let spots of rust appear;
One of your men might chance to inquire
What causes a clinker in the fire,
About CO_2, how to explain—
Is the answer ready in your brain?

He might ask you this, which might you stump—
Figure the horsepower of a pump;
Or of a valve, the negative lap—
The answer you cannot tell, mayhap.
He surely thinks you can answer him,
So it's best to keep your brain in trim.

Study your text books and journals through,
Broaden your knowledge as good men do;
Prepare for offhand questions well,
So that the answers you surely can tell;
Get all the information you can,
And be an efficient, skilful man.

Concord, N. H. C. H. Willey.

NEW BOOKS FOR MARINE ENGINEERS

Strength of Ships. By A. J. Murray. Size, 5⅝ by 8¾ inches. Pages, 400. Illustrations, 215. Folding plates, 3; folding table, 1. New York and London: 1916. Longmans, Green & Company. Price, $5.00 net.

If it were not for the fact that the scantlings for steel ships of various types and proportions were arbitrarily fixed by the classification societies, the need for text and reference books containing the detailed application of mathematical formulæ for the determination of size and strengths of parts of the ship's structure would long ago have brought before the public books dealing with the strength of ships. As matters stand, however, the ship designers are relieved of much laborious work in determining in each case the strength of parts by the existence of the rules and regulations of the classification societies. Notwithstanding this, however, the increasing complexity of ship construction, the development of new designs and departures from standard arrangements and proportions are producing a growing demand for a fuller and more widespread knowledge of the strength problems underlying ship design. This book, therefore, which is claimed to be the first of its kind published in the English language, should meet such a demand. The work is the outcome of practical experience and is treated from the practical standpoint. The elements of the theory of stress, strain and elasticity are concisely set forth, and later their application is shown to problems of design comprising beams, columns, shafts, bulkheads, plating, riveting, brackets, rudders and miscellaneous fittings, while considerable space is devoted to longitudinal and transverse strength. In all, the book contains fourteen chapters; and while much of it is largely of academic interest, nevertheless it will undoubtedly be found of practical value in many respects for ship designers.

Steam Turbines. By William J. Goudie, B. Sc. Size, 5½ by 8½ inches. Pages, 520. Illustrations, 230. London: 1917. Longmans, Green & Company. Price 12/6 net.

The first portion of this book is devoted to detailed descriptions of commercial types of steam turbines now on the market, while the second portion is devoted to what may be termed the technical part of the subject; that is, the mathematical discussion of the action of steam in the turbines and the determination of the size and shape of the various parts. While the book has been written primarily to suit the requirements of engineering students, it will also be found useful by engineers who have to deal with the design and operation of turbines, for the reason that the production of the commercially successful turbine depends to a considerable extent on the use of design coefficients derived from practice, and in this book these have been applied to suit the conditions of each particular case. The fundamental principles underlying any scheme of design are clearly defined and the practical limitations to the application of theory which experience has shown to be necessary in successful turbine work are stated. By the introduction of practical coefficients and data quoted from various reliable sources, the author has endeavored to place a practical system of calculation before the reader. The matter is arranged progressively, so that the reader may work through the detailed calculations relating to the various portions of the machine in a logical order, finally ending with a general method of calculation for the provisional determination of the general proportions of any given type to fulfill specific conditions of operation. The book deals only with the turbine proper, as the allied subjects of condensers and auxiliaries have not been touched upon.

The Submarine Torpedo Boat: Its Characteristics and Modern Development. By Allen Hoar. Size, 5¼ by 7¾ inches. Pages, 211. Illustrations, 84. Folding plates, 4. New York: 1916. D. Van Nostrand Company. Price, $2.00 net.

While this book was written for the general reader, it is of value to technical men and engineers, as it faithfully explains the inherent characteristics of the submarine boat, the problems involved in its design and construction, the difficulties of operation and its present limitations. The writer even goes so far as to prophesy its future possibilities, although this is a field in which few are capable of speaking with authority.

In their present stage of development the most important feature in the design of submarines is the means of propulsion both on the surface and under water. Only a brief chapter is given to this topic, and it is to be regretted that this question was not dealt with more fully.

Useful information is given regarding the means of defense against submarine attack, and the tactical evolutions of the submarine as well as the handling of torpedoes. The text is well illustrated not only by excellent photographs but also by drawings and diagrams giving the reader an excellent idea of the details of modern submarine boats.

The Mechanical World Pocket Diary and Year Book has reached its thirtieth year of publication. This volume, size 4 by 6 inches, contains 330 pages of useful engineering notes, rules, tables and data. Many sections of the book have been thoroughly revised and much new information has been added. The book is published in England by Emmott & Co., Ltd., Manchester, and in the United States by Norman, Remington & Co., Baltimore, Md. Price, postpaid, 40 cents.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Receiver Pressures in Triple Expansion Engine

Q. (871).—How are the receiver pressures in triple expansion engines figured out? Give an example showing each cylinder doing the same amount of work, or as near to it as can be obtained?

A. (871).—If the engine is designed or built, the desirable receiver pressures for wide open throttle runs may be *roughly* calculated by the following empirical expressions which have been derived from a large number of trials of engines both of the express and merchant types, all of which had good distributions of work:

$$\text{Pressure in first receiver} = \frac{\text{Boiler pressure} \times \text{volume high-pressure cylinder}}{\text{Volume intermediate-pressure cylinder}}$$

$$\text{Pressure in second receiver} = \frac{2.0\ (\text{pressure in condenser} + 8\ \text{pounds})}{\text{Cut-off in low-pressure cylinder}}$$

All pressures are absolute.

Cut-off in low pressure cylinder is expressed as decimal of stroke.

There is no way of accurately predicting offhand the probable pressures, as they are affected greatly by the details of construction of the engine, and it should be borne in mind that the only reliable gage as to whether an engine is developing equal work in each cylinder is from the indicator diagram.

Dimensions of Propeller for Motor Boat

Q. (872).—I have a motor boat which has the following dimensions: Length over all, 40 feet; length on waterline, 39 feet; beam (extreme), 5 feet 9 inches; beam (load water line), 4 feet 10 inches; draft (extreme), 2 feet 3 inches; draft (mean molded), 9 inches; displacement, 3,950 pounds. Will you please tell me what speed she will make if I put in a 42 brake horsepower motor (1,000 revolutions per minute), and what dimensions the propeller should have?

A. (872).—If the hull is well formed, 42 brake horsepower should drive it at 18.5 knots, or 21.5 miles per hour. A suitable propeller would be one having a diameter of 18.3 inches and a pitch of 26.5 inches with three blades of large width and having sharp edges.

Wear on Crosshead and Crank Pin Brasses

Q. (873).—Where is the most wear, in the crosshead pin and brasses, or the crank-pin and brasses, and why?

A. (873).—The most wear occurs in the crankpin brasses. The wristpin brasses should require very little attention. The crankpin itself wears but little and the wristpin, barring accidents, should run for years without needing to be trued up. The principal reason why the crankpin brasses wear more than the wristpin brasses is that the distance the surfaces rub by each other is much greater there than at the wristpin. The designed load per unit of area of bearing at the crankpin is about one-half that allowed at the wristpin, but the rubbing speed of the crankpin bearing is about fifty times as great as the average rubbing speed of the wristpin bearing, which is, moreover, a reciprocating motion.

Clearances in Main and Crank Pin Bearings

Q. (874).—What clearances should be allowed in adjusting main and crank-pin bearings of a 3,000 indicated horsepower marine engine?

A. (874).—Bearings of large size are usually adjusted to give a "lead" or radial clearance of the cap of from eight to fourteen-thousandths (0.008 to 0.014) inch. Small bearings capable of nice adjustment and which receive good care may have caps set to give a "lead" of 0.0005 inch.

Cylinder Proportions in Triple Expansion Marine Engine

Q. (875).—Will you please tell me what consideration regulates the cylinder proportions in a triple expansion marine engine; that is, what determines the selection of the ratios of the high-pressure cylinder to the low-pressure cylinder, and the intermediate to the low-pressure?

A. (875).—Usually the low pressure cylinder diameter is first determined by any of the methods commonly given in text books. With this settled, the diameter of the high pressure is then a function of the number of expansions to be used and the cut-off in the high pressure cylinder. Dividing the volume of the low pressure cylinder by a number of expansions gives the volume of the high pressure cylinder at cut-off and selecting a value for cut-off, the cylinder diameter becomes determinate. Cut-off in the high pressure cylinder occurs usually at from 70 to 85 percent of stroke, the larger values being used where it is desirable to keep down the weight and size of the high pressure cylinder. The intermediate cylinder is usually determined in accordance with the following expression:

$$\text{Diameter intermediate-pressure cylinder} = K\ (\text{diameter low pressure} \times \text{diameter high pressure})^{1/2}$$

For merchant ships, K = 1.0, for naval vessels it ranges from 0.9 to 1.0, as these usually have a much smaller number of expansions.

Indicated vs. Brake Horsepower

Q. (876).—What is a reasonable value for the percentage of the indicated horsepower that moderate-sized reciprocating marine engines will deliver as brake horsepower? Is it 70 percent, 75 percent or 80 percent, or what? For a specific example take a triple expansion condensing engine that I have in mind, which develops about 900 indicated horsepower at 180 revolutions per minute with steam at the throttle of 175 pounds. I wish to predict what the brake horsepower will be, and should be very glad if you would give me the latest information.

A. (876).—The value of the mechanical efficiency

$$\left(\frac{B.H.P.}{I.H.P.}\right)$$

for modern marine engines varies considerably with the size of the unit and is affected by the condition of the engine as regards alinement, bearings, etc. A commonly accepted value for engines of 2,500 indicated horsepower and over, of good construction and condition, is 92 percent. For an engine of the size you mention 85 percent to 88

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

† "Design of Steam Boilers," Haven & Ewett.

percent would be a reasonable range. Engines of larger size have been quoted as having mechanical efficiencies of 95 percent or over, but these values are abnormal, as also are values below 85 percent.

Superheat in First Effect of Double Effect Evaporator

Q. (879).—How much superheat should be carried on the first effect of an evaporator running double effect? The plant provides make-up feed and water for ship's purposes. The evaporator operates on live steam at 150 pounds pressure gage in the first effect and has a rated capacity of 7,500 gallons per twenty-four hours. How will it affect the capacity if I operate the two units single effect?

A. (879).—Effective separation is better than carrying any superheat. The only reason for superheating is to prevent the vapor carrying over entrained drops of salt water and thus contaminating the water delivered. Superheating, however, accelerates corrosion and pitting, and best practice now tends toward large vapor space and effective mechanical separation.

The *capacity* of a double effect is no greater than a single effect operating between the same range of temperatures, but the *economy* is about twice as great. So, if you cease operating the two units which you have, in double effect, and operate each single effect between the 150 pounds and the same back pressure as now is used on the second effect, you will obtain approximately twice as much total water, as *each* unit will give the *same* amount that is now produced by the whole plant, but the water delivered per pound of live steam will be about one-half that which you are now obtaining and you will use altogether approximately four times as much live steam and obtain nearly twice as much feed.

Efficiency as Basis for Comparison of Steam Engine Performance

Q. (880).—Will you kindly tell me what is the proper efficiency to use as a basis for the comparison of steam engine performance? I have found both of the expressions given below used and they do not agree for a given set of conditions. To make the case a concrete one, assume that I have an engine operating between 150 pounds gage and 26 inches vacuum. What is the ideal efficiency?

Formula I

$$\text{Ideal efficiency} = \frac{T_1 - T_2}{T_1}$$

Formula II

$$\text{Ideal efficiency} = \frac{H_1 - H_2}{H_1 - q_2}$$

Where T_1 and T_2 are the absolute temperatures at supply and discharge.

H_1 and H_2 are the heat contents at supply and discharge.

q_2 is the heat of the liquid at the discharge pressure.

A. (880).—The two expressions you quote are each correct for a certain ideal cycle, the first for the Carnot cycle and the second for the Clausius or Rankine cycle. The second is preferable as a basis for steam engine comparison. Fundamentally the two are the same, however, the only difference being in the manner in which the heat is added. The basic expression for efficiency of any engine which transforms heat into work is

$$\text{Efficiency} = \frac{\text{Heat transformed into work}}{\text{Heat supplied}},$$

which is the same as

$$\text{Efficiency} = \frac{\text{Heat supplied} - \text{heat rejected}}{\text{Heat supplied}}$$

when the engine transforms *all* of the heat available in its range of operation into work, and this is what the ideal engine does.

The Rankine cycle assumes steam is admitted to the cylinder at constant pressure up to the cut-off, at cut-off adiabatic expansion occurs (no heat passes into or out of the cylinder) to release, then, the steam is exhausted on the back stroke. The heat supplied to generate one pound of steam and push it into the cylinder up to cut-off is the heat contents minus the heat of the condensate ($H_1 - q_2$). The heat rejected is the heat that is given out in the exhaust after release or $H_2 - q_2$ as the condensate is assumed to be fed directly back to the boiler. The following is then the efficiency:

$$\text{Efficiency} = \frac{(H_1 - q_2) - (H_2 - q_2)}{H_1 - q_2} = \frac{H_1 - H_2}{H_1 - q_2}$$

(The q_2 is always looked up for the back pressure in the condenser regardless of what the feed temperature may be.) An engine operating with dry steam at 150 pounds gage, 26 inches vacuum, has an ideal or Rankine efficiency, figured as follows:

150 pounds gage = 164.7 pounds absolute.
Entropy = 1.56 for dry steam.
26 inches vacuum = 1.95 pounds approximate.
At entropy = 1.56, and p_1 = 164.7 pounds.
At entropy = 1.56, at p_2 = 1.95 pounds.

H_1 =	1195	B. T. U.	1195
H_2 =	904	q_2 =	93
$H_1 - H_2$ =	291	$H_1 - q_2$ =	1102

$$\text{Efficiency} = \frac{291}{1102} = 26.4 \text{ percent.}$$

NOTE.—H_1 and H_2 must be looked up at the entropy corresponding to the initial pressure and quality. The computation can most readily be made from steam and entropy tables of Peabody, or any temperature entropy diagram.

The other expression for efficiency applies to the Carnot cycle, which considers that there is no steam *supplied* and *exhausted*, but that a constant amount remains under consideration all the time and that the addition and subtraction of heat changes its state and makes it do external work. The Carnot efficiency is sometimes used for calculating ideal plant efficiency, considering the boiler, engine, etc., as one unit. The Rankine is, however, preferable for comparison of *engine* performance.

Passes in Surface Condensers

Q. (881).—Are marine condensers ever built with the circulating water making any different number of passes than two?

A. (881).—Yes, modern condensers for high speed vessels are frequently single pass condensers.

Determination of Superheat in Steam

Q. (883).—How can you tell whether or not steam is superheated?

A. (883).—Measure the pressure and temperature of the steam by a steam gage and a thermometer. Look up in the steam tables the temperature corresponding to the gage pressure plus 14.7 pounds. If the temperature as given by the thermometer is higher than this, the steam is superheated and the amount of superheat in degrees is the excess of the observed temperature over that given by the steam tables. The temperature is best obtained by inserting a thermometer well filled with oil or mercury, into the steam line and placing the thermometer in this. Care should be taken to apply a stem correction to the reading. For example, suppose the gage shows 150.3 pounds and the thermometer actually reads 380 degrees F. Applying a stem correction of about 6 degrees for this case, the true temperature is 386 degrees. From the steam tables the temperature at 150.3 pounds + 14.7 pounds, or 165 pounds absolute, is 366 degrees F., the superheat is then 386 degrees — 366 degrees = 20 degrees.

ECKLIFF CIRCULATORS are well represented in ships of the United States Government now under war orders. Several of the larger Scotch-boilered ships of the U. S. Navy and the War Department are Eckliff-equipped; also boats of the U. S. Coastguard Service, U. S. Lighthouse Service, U. S. Coast and Geodetic Survey and Bureau of Immigration. In addition to these, Eckliff circulators have been installed in the boilers of a large number of freighters, steam yachts, fishing steamers and other craft.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

With an urgent demand for every available ton of shipping that can be produced in the shortest possible time, by both the steel and wooden shipbuilders of the United States, the resources of the steel and machinery markets will be taxed to the utmost for material and equipment. A considerable list of new equipment has been issued for the government navy yards and also by some of the larger private shipbuilding establishments. In addition to this, numerous new shipbuilding companies are being incorporated, sites secured and plans prepared for shipbuilding facilities. Woodworking machinery is especially in demand.

One of the most serious problems connected with the urgent demand for vessel tonnage is the securing of skilled and unskilled labor for this work. The Navy Department is in urgent need of ship draftsmen. Millions of dollars are available for new construction and for facilitating construction already begun, but all the shipbuilding work undertaken by Government yards is retarded by a shortage of ship draftsmen. Applications for such positions will be received by the United States Civil Service Commission, Washington, D. C., at any time, and those found qualified will be offered employment at once, at salaries ranging from $3.28 to $6.00 and over per diem.

Strenuous efforts are also being made to secure carpenters for employment in building the large fleet of wooden cargo ships which is now being undertaken by the United States Shipping Board.

Announcement was made on April 11, by the Secretary of the Navy, that Charleston, W. Va., has been selected as the location for the Government armor plate plant for which Congress has appropriated $11,000,000. The construction of the plant will be commenced at once and driven to quick completion.

Shipping Committee Appointed to Consider Methods of Increasing Tonnage

At a meeting of the Council of National Defense at Washington, D. C., on April 21, there was created a committee of shipping to advise with the United States Shipping Board, and to report to the Council, as to the best method of increasing tonnage available for shipment to the Allies.

This committee consists of Hon. William Denman, chairman of the Federal Shipping Board; P. A. S. Franklin, president, International Mercantile Marine Company; H. H. Raymond, president, Coastwise Shipping Association; Hon. Eugene T. Chamberlain, commissioner, Bureau of Navigation, Department of Commerce; D. T. Warden, manager of foreign shipping department, Standard Oil Company; L. H. Sherman, vice-president, W. R. Grace & Company; A. H. Bull, of A. H. Bull & Company, and Frank C. Munson, of the Munson Steamship Line.

Electric Drive for Battleships Colorado and Washington

Contracts totaling approximately $2,000,000 have been placed recently with the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa., by the New York Shipbuilding Company, for furnishing the necessary electrical equipments for the propulsion of the new super-dreadnoughts *Colorado* and *Washington*.

The equipments to be furnished are practically duplicates of that contracted for by the Navy Department for the U. S. S. *Tennessee*, now building at the New York Navy Yard. The four propellers, as in the case of the *Tennessee*, instead of being mechanically connected to turbines, are to be driven by individual motors. The current for the motors will be furnished by two turbine generators.

In addition to the main generating equipments and propelling motors, the contracts include auxiliaries for the main turbine generators and smaller auxiliary turbine generators for supplying light and power throughout the ships. Westinghouse electric motors will also be utilized for doing nearly all the work on board, from raising the anchor to steering.

Board Appointed to Value Merchant Vessels Offered to the Government

A board of appraisal to appraise the value of all the vessels offered for Government use has been appointed by the Secretary of the Navy. The board consists of Captain A. S. Halstead, U. S. N., now stationed at the Naval War College, Newport, R. I.; Naval Constructor H. G. Gillmor, U. S. N., now on duty with the Board of Inspection and Survey, and Lieutenant-Commander E. C. Kalbfus, U. S. N., on duty with the General Board. In addition, the Secretary directed that three civilians be added. They are Daniel Bacon and Stevenson Taylor, of New York City, and Albert L. Swasey, of Taunton, Mass. These three civilians have received the rank of lieutenant-commander in the Naval Reserve. The board will have offices with the Naval Reserve at 26 Cortlandt street, New York City.

Shipbuilding Contracts

According to reports, lake shipyards have recently received orders to build about seventy steel ships for the overseas trade, for delivery during 1918. Most of these boats are of Welland Canal size, but several are larger and will be taken through the canal in two sections. It is reported that thirty-three of these boats will be built by the American Shipbuilding Company, Cleveland, Ohio, and twenty-nine by the Great Lakes Engineering Works, Detroit, Mich.

According to latest reports, the Cunard Steamship Company, Ltd., whose New York office is 24 State street, is planning to place orders in this country for 114 ships, to range in size from 8,000 to 17,000 tons, and to cost about $120,000,000.

The Mann Yacht Building Company, Baltimore, Md., has received a contract from the city of Baltimore to build a 45-foot police boat.

The Herreshoff Manufacturing Company, Bristol, R. I., has received a contract from A. I. Du Pont, Wilmington, Del., to build a fast scout patrol boat, 110 feet long.

The American Shipbuilding Corporation, Spokane, Wash. will build eight five-masted auxiliary schooners at its Warrentown, Ore., yards.

The Secretary of the Navy has awarded contracts for the construction of twenty-four torpedo boat destroyers, as follows: To the Union Iron Works Company, San Francisco, Cal., 10; to the Fore River Shipbuilding Corporation, Quincy, Mass., 8, and to the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., 6.

The Cunard Line, 21 State street, New York, is credited with having placed orders in the United States for a total of thirty-eight steamships, including ten ships to be built by the Ames Shipbuilding & Dry Dock Company, Seattle, Wash.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., to build four steamships, making a total of eight steamers which the United Fruit Company is now building in the United States.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from W. R. Grace & Company, Hanover Square, New York, to build two more steamships.

According to recent reports, Seattle shipbuilding plants now have under contract ships aggregating a total contract price of more than $64,000,000.

John Coughlan & Sons, Vancouver, B. C., who are building three 8,800-ton steel steamers for Norwegian interests, have received a contract from the British Government to build three steel steamers of the same size.

The New Jersey Dry Dock & Transportation Company, Elizabethport, N. J., is building a steamship for the Moore Lumber Company, two tugs for the Central Railroad of New Jersey, 143 Liberty street, New York, and a steam lighter for the Lehigh Valley Railroad Company, 143 Liberty street.

F. S. Bowker & Sons, Phippsburg, Me., have an order to build a 700-ton four-masted schooner.

Shipyard News

The Navy Department, Washington, D. C., is preparing plans for extensive improvements at the Brooklyn, Portsmouth, Philadelphia, Norfolk, Charleston and Mare Island Navy Yards. Eighteen million dollars has been appropriated for the purpose, and of this about $6,000,000 will be used in enlarging the League Island Navy Yard at Philadelphia.

The Navy Department has given a contract to the Maryland Dredging & Contracting Company, Baltimore, Md., for the construction of the new dry dock of the League Island Navy Yard. This dry dock will cost about $3,000,000, and will be 1,100 feet long, 200 feet wide and 80 feet deep.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., is having plans drawn for the addition of a machine shop to the Brooklyn Navy Yard to cost about $400,000.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., is planning large additions to its yard at Chester, Pa.

The Fore River Shipbuilding Corporation, Quincy, Mass., will spend about $1,500,000 to build a new set of ways, as a result of receiving a contract to build one of the new battle cruisers.

The Columbia River Shipbuilding Company, Portland, Ore., expects to begin ship building in a few days. This concern is one of those which is reported to have contracts to build two ships for the Cunard Line, besides orders received for six steamships for Norwegian parties.

The Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal., is planning to spend $150,000 in the installation of metal-working machinery. This company is said to have received contracts to build two 5,000-ton steel freight steamships.

The F. O. Smith Shipbuilding & Dry Dock Company, Norfolk, Va., has let a contract to build a machine shop, storeroom, and boiler and blacksmith shop.

The Rolph Coal & Navigation Company, San Francisco, Cal., which recently bought the H. D. Bendixson Shipyard at Eureka, Cal., has bought 2,000 additional feet of water front, with the intention of enlarging the plant.

The Pacific Coast Shipbuilding Corporation has bought a site at Alviso, Cal., and is planning a wooden shipbuilding plant.

J. P. Clark, Los Angeles, and Henry M. Coit and George W. Bush, of San Diego, Cal., are organizers of a company to operate a shipbuilding plant at San Diego. It is reported that they have already secured a tract of land.

J. W. Paterson, Aberdeen, Wash., is at the head of a project to build a shipyard in Aberdeen. He is reported to have already secured contracts to build several vessels.

The National Shipbuilding Company, Seattle, Wash., has been reorganized, with a capital of $2,000,000, by William J. Fisher, Tacoma; George A. Lee, Seattle, and Judge Zent, Spokane.

The Wilmington Canning Company, Los Angeles, Cal., has announced that the company is planning the construction of a shipbuilding plant, and that it has secured 150 acres of land and will begin operations immediately.

Land recently purchased opposite New London, Conn., in the town of Groton is to be used by the Groton Iron Works to establish a large shipyard. It is understood that $1,000,000 is to be spent. Full information regarding the yard can be had by addressing E. O. Cutler, Palmer Shipbuilding Company, Noank, Conn.

McBride & Law, Beaumont, Tex., have purchased land and will establish a shipyard of sufficient capacity to build six wooden vessels at one time, the vessels varying from 500 to 2,000 tons capacity.

George W. Bush, Marsh-Strong building, Los Angeles, Cal., has made application to the City Council of San Diego for a lease of land, with the intention of erecting a shipbuilding and repair plant.

Preparations are under way in Canada for the establishment of a great shipbuilding industry under Government aid. J. W. Norcross, vice-president and managing director of the Canada Steamship Lines, Toronto, Can., has been appointed Director of Shipbuilding of the Dominion of Canada.

The Lone Star Shipbuilding Company has been incorporated, with a capital stock of $2,000,000, for the purpose of building a shipyard at Beaumont, Tex. George B. Leighton, of Boston, is president of the company, and is said to have a contract to build ten schooners.

The Coast Shipbuilding Company, Portland, Ore., has been organized, with a capital stock of $400,000, by James B. Kerr, A. L. Mills, Donald W. Green and Charles E. McCulloch, all of Portland.

Reed Bros., South Somerset, Mass., are rebuilding and enlarging their shipyard.

George W. Moore, Bandon, Ore., is at the head of a group of capitalists who are said to be planning the erection of a shipbuilding plant in Bandon.

F. C. Knapp, president of the Peninsula Shipbuilding Company, Portland, Ore., announces that plans are being made for the enlargement of the yard.

The Manistee Iron Works, Manistee, Mich., has been purchased by the Northern Transportation Company, of Baltimore, Md. The new owners will immediately begin the construction of six wooden barges, each to have a carrying capacity of 3,000 tons.

The West Waterways Boat Building Company, Seattle, Wash., has been incorporated to build fishing vessels, launches, etc.

The Everett Shipbuilding Company, Everett, Wash., has been incorporated by D. W. Locke, A. J. Stohr, R. J. Weekin and others.

The Columbia Transportation System is being formed to build a shipbuilding plant on the Columbia River near Portland. Wallace R. Struble, secretary of the Columbia & Snake River Waterways Association, Portland, Ore., is one of those interested.

John F. Craig, Long Beach, Cal., has acquired a site for a shipbuilding plant, which he plans to build immediately.

It is reported that J. Fred Larsen, Portland, Ore., is about to establish a wooden shipbuilding yard at Florence, Ore.

The Shallow Water Boat Company has acquired the plant of the Ripley Steel Boat Company, Alton, Ill., and, according to report, will use it to manufacture submarine chasers and similar craft.

The Housatonic Shipbuilding Company, Stratford, Conn., has been incorporated to build wooden ships. The new company has acquired 40 acres of land on the Housatonic River. Fred E. Morgan is president and Carl Foster treasurer. It is reported that work will shortly be begun on ten schooners.

It is reported that the plant of the Standard Cast Iron Pipe Company, Bristol, Pa., is to be converted into a shipbuilding yard.

J. W. Hansbrough has bought 52 acres of water front at Vallejo, Cal., and is reported to be about to erect a shipyard.

Henry Piaggio, Gulfport, Miss., is planning to build a shipyard and is in the market for woodworking machinery.

The Downey Shipbuilding Corporation, New York City, has been incorporated in Delaware, with a capital of $5,000,000, to construct and operate a local shipbuilding plant. Wallace Downey, 120 Broadway, head of the new organization, has recently acquired the structural steel and iron plant of Milliken Bros., Inc., Milliken, Staten Island, including about 1,800 feet of water front property, for the proposed works: an extensive shipbuilding department with six construction slips will be installed. The plant will specialize in the building of freighters of standardized type. Herbert E. Latter and C. M. Rimlinger, Wilmington, Del., are local incorporators.

The R. G. Packard Company, Twenty-eighth street, Bayonne, N. J., manufacturer of dredging machinery, has been granted riparian rights to property fronting on the Raritan River, near South Amboy, by the State Board of Commerce and Navigation, for a consideration of about $13,400. The company is said to be planning for the erection of a shipbuilding plant on the site.

To meet the demand for forgings that has developed with the shipbuilding industry a new company has been formed, which will erect a large plant on Whatcom avenue in Seattle. This company, the Pacific Engineering & Construction Company, has already started work on its shops, and their hydraulic forging presses, drop hammers, steam hammers and other equipment are on their way there from the East. R. C. Monteagle, formerly assistant general manager of the Seattle Construction & Dry Dock Company, is president and general manager of the new concern.

The Skinner & Eddy Shipbuilding Company has acquired a 15-acre site, including their present plant, for a price that has been given out at $1,500,000. This will give them much

German Vessels at Hoboken, N. J., Piers Seized by the United States Government

needed room for expansion, as the 9 acres added not only include room for more slips but will provide space for new machine shops, foundry, etc. All of the ships built by the Skinner Eddy Company have been powered with turbines bought from the General Electric Company, but with the new shops the company will start building 2,500-horsepower, triple-expansion engines.

Launch of the S. V. Harkness

On March 22 the Skinner & Eddy Corporation, of Seattle, Wash., launched the first of two bulk oil tank vessels building for the Standard Oil Company of New Jersey. She was the *S. V. Harkness,* with port of registry at Bayonne, N. J., and will be delivered to the owners the latter part of April.

The general dimensions of the ship are: Overall length, 435 feet 6 inches; beam, 57 feet; depth, 31 feet 6 inches; load draft, 24 feet; speed, 10½ knots; deadweight, 9,000 tons. She is a single screw ship, of poop, bridge and forecastle type, with a partial second deck and machinery located aft, and is being built on the Isherwood system to Lloyds Class 100 A1, and is the largest commercial vessel so far built in the Northwest, exceeding in length by 11 feet 9 inches the *Neils Neilson,* also built by the Skinner & Eddy Corporation.

She will be equipped with three Scotch marine boilers, 14 feet 9 inches inside diameter by 11 feet long, having about 2,700 square feet of heating surface when burning oil with a working pressure of 190 pounds. They were built by the Commercial Boiler Works, also of Seattle. These will furnish steam to the Curtis type turbine of the General Electric Company's manufacture, developing 2,500 shaft horsepower at 100 revolutions per minute, geared to the shaft driving a four-blade propeller of 16 feet 9 inches diameter. There will be five stages in the ahead and two stages in the reverse turbine. Her sister ship is the *Josiah Macy,* and will be launched on April 21. Delivery of the latter ship will be made the latter part of May.

General View of the New Shipyard of the Duthie Shipbuilding Company, Seattle, Wash.

Marine Terminal Improvements

The Export Railway Company, Tampa, Fla., is planning to spend $1,000,000 in building phosphate terminals at Tampa.

The Western Maryland Railroad Company, H. R. Pratt, Continental Trust building, Baltimore, Md., chief engineer, plans to build a pier at McComas street.

The Empire Limestone Company, 19 Hudson street, Buffalo, N. Y., has applied to the City Council of Buffalo for permission to build a dock.

The Western Fuel Company, 6 Grand avenue, Milwaukee, Wis., has let a contract to the Great Lakes Dredge & Dock Company, 491 Canal street, Milwaukee, to build an 800-foot dock.

A. B. Pouch, president of the American Dock Company, 17 State street, New York; J. B. Kilsheimer, president of the Staten Island Development Company, and others, are planning to build docks and warehouses on Staten Island. Applications have already been made for pier accommodations and a large frontage on Edgewater street has been secured. The general layout provides for several large covered piers of more than 1,000 feet in length, together with warehouses, wharves, etc. Many millions of dollars will be spent.

The Healey-Tibbits Construction Company, Main and Market streets, San Francisco, Cal., have received a contract from the State Board of Harbor Commissioners, California, to build pier 31, at a cost of $283,600.

Shipbuilding Aided by a New "Monroe Doctrine"

Shipbuilders of the United States are faced not only with the problem of replacing a vast amount of sunken tonnage but also with an opportunity and an excuse to build an American merchant marine, and, at the same time, to learn an economy and efficiency in ship production which will enable them to sustain and increase such a marine even amidst the war of competition in ship construction which is bound to follow the approaching peaceful settlement of the world's present conflict.

In building such a marine it is necessary to begin to figure on a reduction in the waste of material and an increase in the efficiency of labor. Cost systems must be established with mechanical devices to determine costs accurately and with despatch. Advantage must be taken of every opportunity to make one man do as much as two, three or four by putting more efficient machinery in his hands. Equipment must be placed in the hands of engineers which will relieve them of the boredom of making mental-pencil-and-paper computations and will leave their minds free for creative ideas.

By installing a Monroe Calculating-Adding Machine, for example, the figure work of a cost system can be turned out, it is claimed, two or three times as fast as by a pencil-and-paper method, and one Monroe machine at the cost of but 14 cents a day turns one or two office men loose to work at something else. Such a machine figures everything from a payroll to the total cost of building a ship, and so easily, it is claimed, that any office boy with a knowledge of figures can operate it. It is because of the Monroe's adaptability to marine figures that the United States Navy Yards at New York, Philadelphia, Portsmouth, Pensacola, Mare Island and Seattle, and The Chester Ship Building Company, The Union Iron Works, and The Bethlehem Steel Company have installed Monroe machines.

This one machine solves all of the most complicated formulæ, though they include even extraction of square and cube root, with which a marine engineer has to deal, for the Monroe not only adds but it subtracts, multiplies and divides just as easily as it adds. Every operation is direct; that is the numbers are set on the keyboard as on any standard adding machine, the crank is turned forward for addition or multiplication and backward for subtraction or division. There is no setting of levers and the operator is not hampered by the use of arbitrary rules. The machine is simple in construction. It is portable, weighs 26 pounds, and occupies less than a square foot of desk space.

In *addition*, the operator sets the numbers in the keyboard and gives the operating crank a turn forward. He has perfect visibility at every stage, and can check each amount as he proceeds before it is recorded on the numeral dials.

Subtraction is a direct operation and no complementary numbers are required. For example, it is desired to subtract $55,796.35 from $78,429.46. The operator sets the $78,429.46 on the keyboard, turns the crank forward, recording the number in the lower dial. He then sets the $55,796.35, turns the crank backward, and the answer, $22,633.11, appears in the lower dial at the right.

To *multiply*, the operation is as follows: It is desired to multiply 4,346 by 122. The operator sets up 4,346 on the keyboard and turns the crank forward two times. He then shifts the carriage one space to the right and makes two more turns. The carriage is then shifted another space to the right, the crank is turned forward once, and the result appears in the lower dial, 530212. The three successive steps taken register on the keyboard and dials as follows:

	First Step	Second Step	Third Step
Upper dial.....	2	22	122
Lower dial.....	8692	95612	530212
Keyboard	4346	4346	4346

It is desired to *divide* 4775.91 by 224. As multiplication is a process of continued addition, and is accomplished by turning the crank forward, so division is a process of continued subtractions, and is accomplished by turning the crank backward. The operator sets the dividend 4775.91 in the keyboard,

Monroe Calculating Machine

and by one turn of the crank forward registers it in the lower dial. He clears the upper dial and the keyboard, and sets the divisor, 224, in the keyboard. He then turns the crank backward, subtracting 224 from the first three figures of the dividend (477) as many times as it can be subtracted, which is two. The upper dial indicates the first figure of the result He then shifts the carriage one space to the left, again subtracts the 224 as many times as possible from the three figures of the dividend that appear immediately above it. He continues this shifting and subtracting until no further subtraction can be made.

The figures as they show up on the machine at the end of each step are as follows:

	First Step	Second Step	Third Step	Last Step
Upper dial...	20.00	21.00	21.30	21.32
Lower dial...	0295.91	071.91	04.71	0.23
Keyboard ...	224	224	224	224

The divisor, 224, remains constantly on the keyboard. At the last step the number appearing in red in the upper dial, 21.32, is the result (quotient); the number in the lower dial, 23, is the remainder. The whole operation requires but three or four seconds. If at any stage of the division too many turns of the crank are made, a row of 9's is brought up at the left of the dividend, instantly indicating the error. To correct this the operator merely turns the crank forward, bringing all the figures back just as they were before the error was made.

It is because of the Monroe's manifold versatility, combined with its direct simplicity, that the machine not only finds its function in doing the simpler calculations of the shipyards but in reducing such a formula as

$$I.\,H.\,P. = \frac{(3200)^{2/3} \times 12^3}{230} \text{ to } I.\,H.\,P. = 1{,}630$$

in about 60 seconds.

The Monroe calculating machine is manufactured by the Monroe Calculating Machine Company, Orange, N. J., and its general offices are in the Woolworth building, New York City.

Joint Banquet of Branches Nos. 4, 3, and 15, American Society of Marine Draftsmen, Hotel Brewster, Boston, Mass., March 24.

Joint Banquet of the Boston (Navy Yard), Quincy and Fore River Government Branches of the American Society of Marine Draftsmen

Twenty-seven members of Boston (Navy Yard) Branch No. 3, forty-nine members of Quincy Branch No. 4, and twelve members of Fore River Government Branch No. 15—eighty-eight in all—attended a joint banquet at the Hotel Brewster, Boston, Mass., on Saturday evening, March 24. Mr. B. G. Barnes, the national secretary of the society and a member of the Quincy branch, of which he has also acted as secretary and president in the past, presided as toastmaster.

Professional entertainers filled in the time between courses with banjo, singing and dancing to the merriment of all, including Messrs. Bradford and Young (W. J. J.). Solos were rendered by Mr. F. J. Townsend, with Mr. Booth at the piano. Mr. F. Yeh, who although not a member of the society is employed as a draftsman and associated with the members of Quincy branch, entertained for about half an hour with well-performed conjuring and sleight-of-hand.

All present thoroughly enjoyed the evening, and the spirit of equity and good fellowship was truly exemplified, as evidenced by the co-operation which existed between Messrs. Wentworth and Prochazka. The thanks of the members were extended to the committee in charge of the banquet for their hard work and untiring efforts, and the programme committee were the recipients of much well-merited praise.

PERSONAL

John Eadie has been appointed general manager of the Wallace Shipyards, North Vancouver, B. C.

J. J. Eason, formerly assistant superintendent of the Mechanical Division of the Panama Canal, has been appointed assistant shop superintendent at the Navy Yard, Norfolk, Va.

L. S. Shaw is now handling the interests of the Terry Steam Turbine Company in Detroit, Mich., and Victor L. Sanderson is connected with the Philadelphia office of the company.

Elliot N. Burwell, naval architect, Boston, Mass., announces that he has moved his offices from the Paddock building, 101 Tremont street, to new and larger offices at 156 State street.

E. T. Klippert, vice-president of the Eckliff Circulator Company, Detroit, Mich., is making a business tour of the Pacific Coast. While on the Coast, Mr. Klippert will inspect installations of Eckliff circulators recently completed there, including several in the large tankers now building for the Standard Oil Company of New Jersey.

W. I. Babcock, engineer and naval architect, has moved his offices from 17 State street to the Equitable building, 120 Broadway, New York.

William W. Sime, Milwaukee, has been appointed manager of the trip-hammer department of the Keller Pneumatic Tool Company, Fond du Lac, Wis., and assumed his new duties April 20.

Joseph A. Sloan, who was manager of the Washington Shipping Corporation's yard on Harbor Island, Seattle, Wash., has opened an office in Seattle as consulting naval architect. Mr. Sloan is still retained by the Washington Shipping Corporation, and is actively interested in several other wood shipbuilding plants.

W. H. Alison, for thirty-five years connected with the Pacific Coast Steamship Company and its successor, the Pacific Steamship Company, Seattle, Wash., has resigned his position as superintending engineer. He obtained his early training with the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, and the Risdon Iron & Locomotive Works, San Francisco. He will be succeeded by John D. Gilmore, chief engineer of the Union Iron Works, San Francisco.

George E. Lawrence, Philadelphia representative of the Eckliff Circulator Company, of Detroit, Mich., has been commissioned a first lieutenant in the U. S. N. R. F., and is now in active service somewhere along the Atlantic. Robert Bellows, of Fleeton, Va., another Eastern agent of the Eckliff Company, is also serving in the U. S. N. R. F., with a commission of warrant machinist. Both of these men are well qualified for the important duties to which they have been assigned, and will prove valuable aids to Uncle Sam.

OBITUARY

Louis Williams, Superior, Wis., for twenty-five years general superintendent of the Superior Shipbuilding Company, died March 22, aged 53 years.

George E. Weed, engineer and shipbuilder, died at his home in New York, April 7, aged 78 years. For the greater part of his active business life he was identified with the Morgan Iron Works, of which the late John Roach was chief owner. After the death of Mr. Roach he became president of the company and the connected Delaware Iron Shipbuilding & Engine Works at Chester, Pa. Mr. Weed was a charter member and vice-president of the Society of Naval Architects and Marine Engineers, and had been treasurer of the Engineers' Club of New York for the past seventeen years.

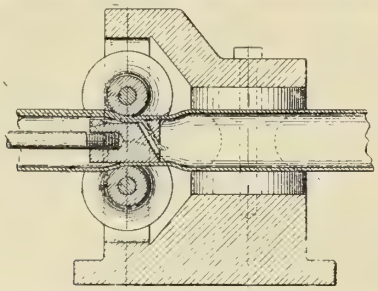
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,215,773. METHOD OF AND APPARATUS FOR REMOVING INTERIOR BURS FROM TUBES. HARRY E. BUTCHER, OF CLEVELAND, OHIO, ASSIGNOR TO THE STANDARD WELDING COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

Claim 1.—The method of removing a bur, or the like, from the interior of pipe or tubing, which consists in passing such pipe or tubing over a suitable member within the same provided with a cutting edge



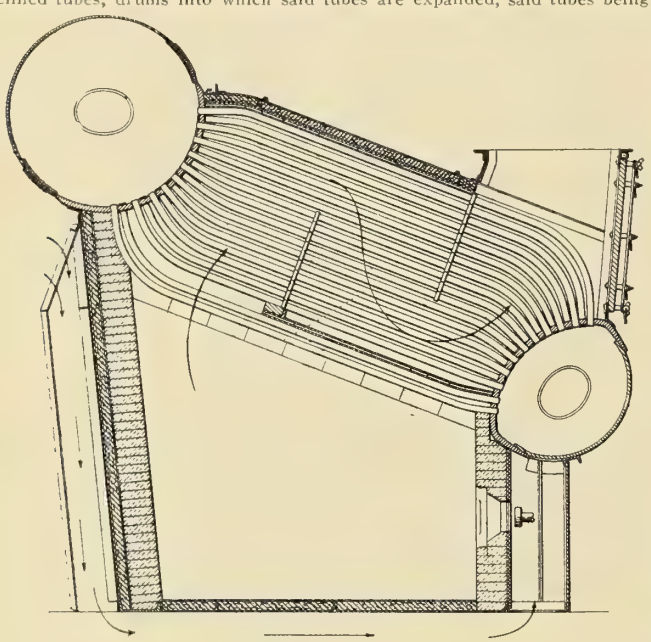
normally out of operative contact with the interior; and simultaneously deflecting the portion of the wall of such pipe or tubing to be operated upon into engagement with such cutting edge. Eight claims.

1,192,546. SUBMARINE PROPULSION. DANIEL FRANCIS MURPHY, OF PRINCE RUPERT, BRITISH COLUMBIA, CANADA.

Claim 1.—In combination with the hull of a submarine vessel, a propeller located adjacent the bow of the hull; means for rotating said propeller; means for adjusting the position of said propeller about an axis extending longitudinally of the hull; two outwardly opening recesses formed one in each side of the hull; a fin adapted to be moved into and out of each of said recesses; and means for moving said fins into and out of said recesses. Ten claims.

1,215,806. WATERTUBE BOILER. WILLIAM D. HOXIE, OF BROOKLYN, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A steam boiler of the class described having a bank of inclined tubes, drums into which said tubes are expanded, said tubes being



curved at both ends and straight for the rest of their length and entering the drums radially, and downcomers at the side of the bank and expanded into said drums. Seven claims.

1,191,794. BOAT DAVIT. ROBERT JONES, OF FLORENCE, ORE.

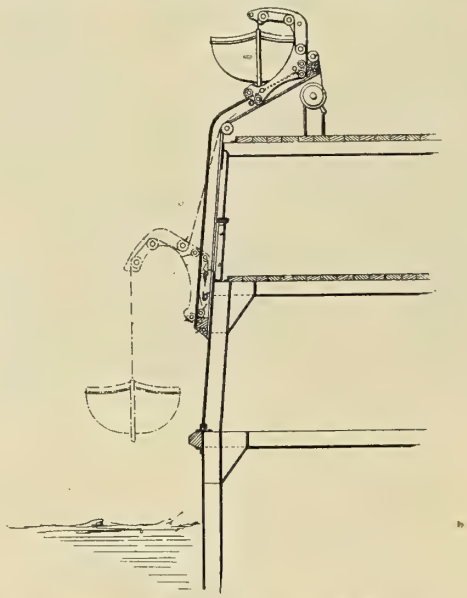
Claim 1.—The combination with a ship, of davits, pivotal and sliding connections between the lower ends of said davits and the side of the ship, head blocks carried by the upper ends of said davits, respectively, sheave wheels in each head block, hangers suspended from said head blocks, a life boat supported by said hangers, cables reeved through said head blocks over the sheaves therein and having the outer ends thereof connected with said hangers, drums connected to the inner ends of said cables, and means for rotating said drums to pull said cables to elevate said life boat and draw said davits inwardly, and means for sliding the davits upwardly in the swinging movement thereof so that the life boat may clear the deck of the ship. Three claims.

1,187,522. SUBMARINE BOAT. HUGO E. GRIESHABER, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a submarine boat, the combination of a hull, a ventilator leading to the interior thereof, an inclosure for the outer end of the ventilator having an opening therethrough, a valve-member and means for moving the valve-member to close the passage through the ventilator or to open that passage and close said opening through the inclosure, said inclosure having a second opening therethrough which is distant from the outer end of the ventilator. Five claims.

1,191,410. MEANS FOR LAUNCHING A SHIP'S BOATS. DANIEL E. ERICKSON, OF VANCOUVER, BRITISH COLUMBIA, CANADA.

Claim 1.—Means for lowering a boat from the deck of a ship, said means comprising the combination with a track secured to the ship ad-

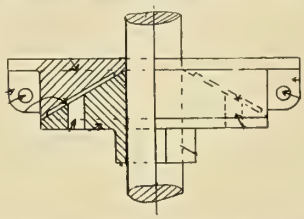


jacent each end of the boat, said track extending from an inboard position on the deck to and down the side of the ship to a position intermediate the deck and the water line, a boat suspending davit connected to and endwise movable on each track, and means for lowering the davits down the track and the boat from the davits. Five claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

100,412/16. RUDDERS OF SHIPS. C. W. A. TAYLOR, OF KYRSTYVILLE, HOLMSIDE AVENUE, DUNSTON-ON-TYNE.

This invention relates to that class of fitting as applied to the deck of ships where the rudder stock passes through same; it has for its object to improve their construction and make them more efficient and is applicable to one or more decks in cases where the rudder stock passes through more than one deck. To the deck of the ship where the stock of the rudder passes through same is fitted a plate (called the deck plate),



either in halves or otherwise, having a hole in the center slightly larger in diameter than the diameter of the rudder stock, and the upper surface of this plate is formed conical either convex or concave. To the rudder stock is fitted another plate (called the stock-plate) either in halves or in one piece, the lower face of this plate being conical in the reverse way to the deck plate, but at the same bevel or taper so that the conical face of the stock plate will bear on and work freely in contact with the conical face of the deck plate. In the concave face of the deck plate are formed two or more cavities and in the convex face of the stock plate are formed cavities; all these cavities are filled with grease or its equivalent before fitting in place, and through the stock plate or deck plate or both means are provided of charging the cavities with grease or the like; one convenient way is by forming holes leading from the top of the stock plate into the cavities.

101,733/16. "IMPROVEMENTS RELATING TO SHIPS' RUDDERS." C. A. JACKSON, OF 12, HAVELOCK TERRACE, SUNDERLAND, IN THE COUNTY OF DURHAM, ENGINEER.

This invention relates to ships' rudders, and has for its object to provide improved means for attaching the rudder stock to the stern frame of a ship. According to this invention, the stern frame is provided with a number of lugs or gudgeons forming part bearings, the complementary parts of said bearings being formed in caps adapted to be secured to the lugs or gudgeons, the bearings being adapted to receive and embrace the rudder stock. Strips or linings of anti-friction metal or material may be provided within the bearings, and steel or like bushes may be provided on the rudder stock to form bearing surfaces.

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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

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Buy a Liberty Bond

WHILE everyone connected with the shipbuilding or shipping industries in this crisis is rendering a service to his country of no less importance and value than that of men in the trenches, nevertheless no one should lose sight of the fact that his responsibilities do not end with the performance of his duties. Every workman in these industries, from the corporation official to the ordinary laborer, is being well paid for his services and can well afford to invest liberally in the $2,000,000,000 (£410,000,000) Liberty Loan with which the Government is to meet the immediate expenses of our share in the war. The terms of investment place this opportunity for patriotic service within the reach of all. Practice economy and invest your savings in Liberty Bonds!

Stop the Confusion and Delay, and Build Ships

FROM the moment, two months ago, when the United States went to war with Germany, the call from our allies has been loud and insistent for ships and more ships. No other nation in the world can supply vessels in sufficient numbers and tonnage to carry the food, men and munitions which must be supplied to Europe—not a year hence, but during the coming twelve months. Can any duty of the United States be more plain, more imperative or more vital than this?

And yet two months have gone by with little but confusion, disconcerted action, misdirected efforts expended at cross purposes and vague promises as a result. Two months ago MARINE ENGINEERING had letters from no less than fifty builders of wooden vessels, who either had wooden cargo ships under construction, which they were ready to place at the disposal of the government, or could provide ways for building new ships. Since then not one of these yards has received a government contract or order for ships.

During the past twelve months, Great Britain and other foreign countries have placed orders with American shipbuilders for over 200 sea-going cargo vessels of over 1,000,000 gross tons. These orders have been promptly accepted by the builders, and in spite of the fact that existing shipbuilding facilities in the United States were crowded with work, means have been provided and satisfactory progress has been made in the construction of these ships. Is there any reason to doubt that the great need for a large volume of new tonnage will not be promptly and satisfactorily met?

Major-General Goethals, general manager of the United States Shipping Board Emergency Fleet Corporation, has been pledged the support of the steel makers for materials for the construction of 3,000,000 tons of steel ships within eighteen months. It is a foregone conclusion that the necessary funds, amounting to $750,000,000, will be provided by Congress, and there should be no further delay in putting this gigantic shipbuilding programme into action. At the same time, the plans already developed for building a large fleet of wooden cargo vessels should be pushed forward with the utmost speed. In this crisis, wooden ships will be of as great value as steel ships, and every ton of shipping that can possibly be produced must be built.

This is the time for action—not disputes and delays. Build the ships!

What the Shipping Board Has Done

UP to May 21 the following contracts have been let by the United States Shipping Board Emergency Fleet Corporation: Merrill-Stevens Company, Jacksonville, Fla., 12 wooden and 4 steel vessels; Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal., 8 steel vessels; G. M. Standifer Construction Corporation, Portland, Ore., 10 wooden vessels; Peninsula Shipbuilding Company, Portland, Ore., 4 wooden vessels. Since that date contracts for 24 additional wooden ships and 6 steel barges have been let, making 68 ships in all.

To expedite the work of construction the Emergency Fleet Corporation has divided the entire coast of the country into eight separate districts, and for each district an inspector has been appointed who has authority to act for the corporation in that district. The districts and inspectors are as follows:

Maine to eastern Massachusetts, inclusive, W. H. Hand, Jr., New Bedford, Mass.; east Massachusetts to Delaware River, New Jersey, Eads Johnson, 115 Broadway, New York; Chesapeake and Delaware and the Atlantic Coast from Philadelphia to Norfolk, C. R. McDermott, Munsey Building, Washington, D. C.; Virginia to Florida (Atlantic and Gulf Coasts), W. V. McGowan, United States Engineer Office, Jacksonville, Fla.; east of Mississippi River to Georgia, Warren Johnson, New Orleans, La.; Texas and the Mississippi River, Charles N. Crowell, Merryville, La.; Pacific Coast, Captain A. F. Pillsbury, 310 Sansome street, San Francisco, Cal., and under Captain Pillsbury, for Puget Sound district, John S. Blain, Securities Building, Seattle, Wash.

Standard Type Wooden Cargo Steamer for United States Emergency Fleet

PLANS and specifications for the standard type wooden cargo steamship to be built by the United States Shipping Board Emergency Fleet Corporation have been prepared by Theodore E. Ferris, naval architect, 30 Church street, New York. The plans provide for a vessel 281 feet 6 inches long over all, 268 feet long between perpendiculars, 46 feet beam over the planking, 45 feet 2 inches beam

molded, 26 feet depth molded and 23 feet 6 inches load draft. The deadweight carrying capacity will be about 3,000 tons. About 1,500,000 feet of lumber, board measure, will be required for each vessel.

Propulsion will be by steam or internal combustion engines of 1,400 horsepower, driving single or twin screws. Owing to the large number of vessels to be built it will obviously be impossible to use a standard type of machinery in all the vessels. The type which is given preference is a single-screw arrangement with triple expansion engines supplied with steam from oil- or coal-fired watertube boilers operating under forced draft. While the majority of the vessels will be powered with steam engines either of the reciprocating type or geared turbines, some of the boats will probably be equipped with heavy oil engines.

In all of the vessels steam is to be furnished at 190 pounds per square inch from either two three-furnace, single-ended Scotch boilers, 14 feet 6 inches inside diameter by 11 feet 2 inches long, having a total heating surface of 4,500 square feet and a grate area of 105 square feet, or by watertube boilers of approved type having a total heating surface of 5,000 square feet.

For single screw vessels, equipped with reciprocating engines, the engine cylinders are to be 19 inches, 32¼ inches and 54 inches diameter by 42 inches stroke, designed to develop 1,400 indicated horsepower at 90 revolutions per minute with a piston speed of 630 feet per minute. In this installation a single surface condenser of 2,500 square feet of cooling surface is to be installed.

In twin screw vessels fitted with reciprocating engines, the engine cylinders are to be 14¾ inches, 25 inches and 42 inches diameter by 27 inches stroke designed to develop 700 indicated horsepower at 115 revolutions per minute, and 900 indicated horsepower at 133 revolutions per minute, with a piston speed not over 600 feet per minute. In the twin screw arrangement, two separate condensers are to be installed, each of 1,300 square feet cooling surface.

In turbine-driven vessels, propulsion is to be by one double reduction geared turbine developing 1,400 shaft horsepower, with the propeller turning at 110 revolutions per minute. With steam at 180 pounds per square inch pressure at the throttle and a 28-inch vacuum, the steam consumption is not to exceed 12.5 pounds per shaft horsepower hour. Reversing turbines are to be incorporated with the ahead turbine designed to develop two-thirds of the full power of the ahead turbine.

The machinery and crew's quarters are located amidships, while forecastle and poop decks are also provided. Each vessel will have accommodations for a crew of 30 men with additional accommodations for 12 gunners, as each vessel will be armed with guns fore and aft. Each vessel will have four cargo hatches, two masts and eight cargo booms. The vessels will be lighted with electricity and fully equipped with wireless and other standard equipment.

The hull construction is of conventional single-deck type with open holds and 'tween deck beams. The frames are double 12-inch by 12-inch, molded 18 inches at the keel and tapering to 10 inches at the deck, spaced 36 inches. Alternate designs for the frames have been provided—one for yellow pine and the other for Douglas fir.

The keel is 16 inches sided by 14 inches molded and is fitted with an oak shoe 3 inches by 16 inches. The garboard strakes are of yellow pine, 10 inches by 14 inches, 8 inches by 14 inches and 6 inches by 14 inches, respectively. The bottom planking is 5 inches by 14 inches; around the bilge it is 6 inches by 10 inches, and the side planking is 5 inches by 10 inches. The upper strakes are 5 inches by 8 inches and the topsides 6 inches by 9 inches, all of yellow pine. The ceiling, also of yellow pine, is 10 inches by 12 inches, increased at the bilge to 14 inches by 14 inches.

The main keelson is made up of six timbers 14 inches by 14 inches with two side keelsons, 14 inches by 14 inches. Wing girder keelsons, 10 inches by 14 inches, are also fitted, in addition to the main keelson. The hull is further stiffened by a double row of stanchions throughout the holds with additional stanchions at the corners of the hatches.

Strengthening of the hull against torsional strains is provided by iron strapping fitted between the outside of the frames and the inside of the planking. This strapping consists of a top chord at the upper deck beams, 8 inches by ¾ inch, extending from 12 feet forward of the forward hatch to 12 feet aft of the after hatch. The plates in this chord are connected by triple riveted butt straps and are fastened to each frame by two 1-inch by 8-inch bolts staggered. Diagonal straps of 4-inch by ½-inch iron let into the outside of the frames and inclined at 45 degrees each way will be fitted so as to meet at the top chord in every other frame space. The diagonals will be connected to the chord by two ⅞-inch rivets and at each crossing by one 1-inch rivet. They are also fastened to each frame timber by one 1-inch by 8-inch bolt. The diagonals are to be carried well down and wrapped around the bilge far enough to overlap the ends of the floor timbers.

Contracts for the construction of these vessels will be made, it is understood, on a lump-sum basis only. The first payment will be made within thirty days after the signing of the contract, and further payments of 5 percent each of the total contract price will be made within sixty and ninety days respectively after the signing of the contract. The following percentages of the contract price of each vessel in the contract will be paid: 20 percent when the keel is laid, 30 percent when completely framed, 15 percent when launched, 10 percent when the machinery is installed, and the balance thirty days after the vessel is delivered and accepted.

Two and One-Quarter Million Tons of Merchant Shipping Building in the U. S.

A thorough canvass of the principal shipyards in the United States, made by MARINE ENGINEERING on May 1, shows that 2,250,000 tons of merchant ships are now under construction, 52.5 percent being built on the Atlantic and Gulf coasts, 33.2 percent on the Pacific coast and 14.3 percent on the Great Lakes.

The report comprises returns from 96 shipyards. In all, 723 merchant vessels of 2,248,200 gross tons are under construction. Three hundred and nineteen of these vessels, aggregating 1,539,354 gross tons, are freight steamships or motorships, 77 vessels of 365,488 gross tons are tankers, 10 vessels of 55,260 gross tons are passenger and freight steamers, and 118 vessels of 159,663 gross tons are wooden ships, either schooners or auxiliary schooners, while the remainder, or 199 vessels of 128,435 gross tons, are miscellaneous craft, such as barges, lighters, car floats, ferryboats, etc.

The output of the various shipyards is shown in Tables I-V. A complete list of all the vessels under construction, showing the hull number, type of vessel, gross tonnage, builders and owners, is issued in printed form (price, 10 cents) and can be obtained by sending directly to the office of MARINE ENGINEERING.

The largest shipbuilding centers in the United States are the Delaware district (including New Jersey and New York) on the Atlantic Coast, and the Puget Sound district

TABLE I.—FREIGHT STEAMSHIPS AND MOTORSHIPS

	Number	Gross Tonnage
Albina Machine Works, Portland, Ore.	6	21,800
American Shipbuilding Co., Cleveland, O.	54	142,600
Ames Shipbuilding & Drydock Co., Seattle, Wash.	12	105,600
Baltimore Dry Docks & Shipbuilding Co., Baltimore, Md.	4	16,480
Bethlehem Steel Co. (Maryland Shipbuilding Plant), Sparrows Point, Md.	10	61,184
Chester Shipbuilding Co., Ltd., Chester, Pa.	8	43,600
Clooney Construction & Towing Co., Westlake, La.	1	1,200
Columbia Shipbuilding Corporation, Portland, Ore.	9	51,570
Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.	4	26,160
M. M. Davis & Son, Solomons, Md.	1	1,000
J. F. Duthie & Co., Seattle, Wash.	7	40,110
W. & A. Fletcher Co., Hoboken, N. J.	3	.....
Fore River Shipbuilding Corp., Quincy, Mass.	7	51,900
Great Lakes Engineering Works, Detroit, Mich.	29	116,200
Harlan & Hollingsworth Corporation, Wilmington, Del.	7	19,339
Manitowoc Shipbuilding & Dry Dock Co., Manitowoc, Wis.	9	20,750
Mathews Shipbuilding Co., Hoquiam, Wash.	4	5,800
Merrill-Stevens Co., Jacksonville, Fla.	1	1,700
Moore & Scott Iron Works, San Francisco, Cal.	7	63,500
Samuel L. Moore & Sons Corp., Elizabeth, N. J.	2	5,230
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.	6	35,800
New York Shipbuilding Corp., Camden, N. J.	16	115,200
Pacific-American Fisheries, So. Billingham, Wash.	6	12,300
Pennsylvania Shipbuilding Co., Philadelphia, Pa.	8	62,800
Pusey & Jones Co., Wilmington, Del.	7	28,000
Seaborn Shipbuilding Co., Tacoma, Wash.	1	1,000
Seattle Construction & Dry Dock Co., Seattle, Wash.	9	53,900
Skinner & Eddy Shipbuilding Corp., Seattle, Wash.	10	57,120
I. L. Snow & Co., Rockland, Me.	1	1,600
Standard Shipbuilding Co., New York.	9	65,700
Staten Island Shipbuilding Co., West New Brighton, N. Y.	8	16,000
St. Helens Shipbuilding Co., St. Helens, Ore.	2	1,950
Sun Shipbuilding Co., Philadelphia, Pa.	8	53,200
Tampa Shipbuilding & Engineering Co., Tampa, Fla.	2	7,000
Texas Co. (Bath Yard), New York.	2	12,000
Toledo Shipbuilding Co., Toledo, O.	12	31,100
Union Iron Works Co., San Francisco, Cal.	18	117,320
Willamette Iron Works & Northwest Steel Co., Portland, Ore.	8	70,000
Winslow Marine Railway & Shipbuilding Co., Winslow, Wash.	1	1,250
Total	319	1,539,354

TABLE II.—TANKERS

	Number	Gross Tonnage
American Shipbuilding Co., Cleveland, O.	1	5,200
Baltimore Dry Docks & Shipbuilding Co., Baltimore, Md.	5	16,250
Bethlehem Steel Co. (Maryland Shipbuilding Plant), Sparrows Point, Md.	2	18,400
Chester Shipbuilding Co., Ltd., Chester, Pa.	7	38,500
Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.	2	14,200
W. & A. Fletcher Co., Hoboken, N. J.	3	.....
Fore River Shipbuilding Corp., Quincy, Mass.	4	26,712
Great Lakes Engineering Works, Detroit, Mich.	1	2,200
Harlan & Hollingsworth Corp., Wilmington, Del.	4	25,305
Merrill-Stevens Co., Jacksonville, Fla.	3	1,600
Moore & Scott Iron Works, San Francisco, Cal.	1	10,000
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.	5	43,673
New York Shipbuilding Corp, Camden, N. J.	7	53,688
Pennsylvania Shipbuilding Co., Philadelphia, Pa.	6	30,000
Riter-Conley Manufacturing Co. (Baltimore Yard), Pittsburg, Pa.	2	3,000
Skinner & Eddy Shipbuilding Corp., Seattle, Wash.	3	19,800
Sun Shipbuilding Co., Philadelphia, Pa.	2	14,200
Tank Ship Building Corp., Newburgh, N. Y.	6	12,000
Texas Co. (Bath Yard), New York.	2	12,000
Union Iron Works Co., San Francisco, Cal.	11	18,760
Total	77	365,488

TABLE III.—PASSENGER AND FREIGHT STEAMERS

	Number	Gross Tonnage
Wm. Cramp & Sons' Ship & Engine Building Co., Philadelphia, Pa.	5	33,400
Harlan & Hollingsworth Corp., Wilmington, Del.	2	13,400
New York Shipbuilding Corp., Camden, N. J.	2	8,000
James Rees & Sons Co., Pittsburgh, Pa.	1	460
Total	10	55,260

on the Pacific Coast. In the Delaware district there are building 254 vessels of 731,316 gross tons. In the Puget Sound district there are building 116 vessels of 522,320 gross tons.

The next largest district is the Great Lakes, where 118 vessels of 321,241 gross tons are under construction. This is closely followed by the Chesapeake Bay district, where 73 vessels of 228,626 gross tons are under construction.

TABLE IV.—WOODEN VESSELS: SCHOONERS AND AUXILIARY SCHOONERS

	Number	Gross Tonnage
Atlantic Coast Co., Thomaston, Me.	3	4,800
G. S. Baxter & Co., Jacksonville, Fla.	3	3,300
Bean Shipbuilding Co., Camden, Me.	3	3,600
Benicia Shipyards Co., Benicia, Cal.	2	2,500
F. S. Bowker & Sons, Phippsburg, Me.	2	1,250
Brunswick Marine Construction Corp., Brunswick, Ga.	5	9,550
Brunswick Shipbuilding Co., Brunswick, Ga.	1	750
Clooney Construction & Towing Co., Westlake, La.	7	4,756
Francis Cobb Co., Rockland, Me.	3	2,747
Columbia Engineering Works, Portland, Ore.	1	300
G. G. Deering Co., Bath, Me.	1	1,400
Chas. E. Fulton, San Pedro, Cal.	2	3,600
Georgia Shipbuilding Co., Savannah, Ga.	2	1,720
Geo. A. Gilchrist, Thomaston, Me.	1	1,200
Gray's Harbor Shipbuilding Co., Aberdeen, Wash.	6	14,400
Richard T. Green Co., Chelsea, Mass.	1	1,300
Hanlon Dry Dock & Shipbuilding Co., Oakland, Cal.	1	3,500
Hillyer-Spearing-Dunn Co., Jacksonville, Fla.	1	780
Howland & Nelson, Beaumont, Tex.	2	2,000
Kruse & Banks, Northbend, Ore.	5	7,000
McEachern Ship Co., Astoria, Ore.	7	12,200
Palmer Shipbuilding Co., Noank, Conn.	4	10,000
Peninsula Shipbuilding Co., Portland, Ore.	4	6,400
Percy & Small, Bath, Me.	3	3,825
Henry Piaggio, Orange, Tex.	5	10,400
Puget Sound Bridge & Dredging Co., Seattle, Wash.	3	7,500
Read Brothers Co., Fall River, Mass.	2	2,200
Savannah Engineering & Construction Co., Savannah, Ga.	3	3,750
Sawyer Bros., Millbridge, Me.	1	600
Schultze Shipyard, San Francisco, Cal.	1	200
Seaborn Shipbuilding Co., Tacoma, Wash.	3	5,700
Sharpstown Marine Railways Co., Sharpstown, Md.	1	1,100
Slidell Shipbuilding Co., Slidell, La.	4	4,600
Standifer-Clarkson Shipbuilding Co., No. Portland, Ore.	2	2,950
St. Helens Shipbuilding Co., St. Helens, Ore.	2	3,270
W. F. Stone Shipyard, Oakland, Cal.	5	4,350
Arthur D. Storey, Essex, Mass.	5	1,165
Townsend Marine Railway & Construction Co., Boothbay Harbor, Me.	3	3,400
E. J. Tull, Pocomoke City, Md.	2	1,600
Washington Shipping Corporation, Seattle, Wash.	4	10,000
Wilmington Iron Works, Wilmington, N. C.	2	4,000
Total	118	159,663

TABLE V.—MISCELLANEOUS CRAFT: BARGES, LIGHTERS, CAR FLOATS, ETC.

	Number	Gross Tonnage
American Bridge Co., Pittsburg, Pa.	93	44,942
American Car & Foundry Co. (Jackton & Sharp Plant), Wilmington, Del.	5	3,071
American Shipbuilding Co., Cleveland, O.	2	700
Wm. H. Baldwin, New Baltimore, N. Y.	2	199
Baltimore Dry Dock & Shipbuilding Co., Baltimore, Md.	1	145
Bath Iron Works, Bath, Me.	1	650
Clooney Construction & Towing Co., Westlake, La.	11	10,500
Coastwise Shipping Co., Baltimore, Md.	11	10,500
Cowles Shipyard Co., Buffalo, N. Y.	2	135
M. M. Davis & Son, Solomons, Md.	7	10,500
Dubuque Boat & Boiler Works, Dubuque, Ia.	2	1,415
W. & A. Fletcher Co., Hoboken, N. J.	13	.....
Great Lakes Towing Co., Cleveland, O.	2	142
Hillyer-Spearing-Dunn Co., Jacksonville, Fla.	2	4,800
Kelly-Spear Co., Bath, Me.	3	5,212
B. P. Lanteri, Pittsburg, Cal.	2	.....
Manitowoc Shipbuilding & Dry Dock Co., Manitowoc, Wis.	2	600
McAteer Shipbuilding Co., Seattle, Wash.	1	20,000
Mathis Yacht Building Co., Camden, N. J.	7	.....
New York Shipbuilding Corp., Camden, N. J.	2	1,530
Pusey & Jones Co., Wilmington, Del.	5	3,100
James Rees & Sons Co., Pittsburg, Pa.	2	300
Rohde & Sons Co. Shipyard, Baltimore, Md.	5	2,950
Southern Transportation Co., Chesapeake City, Md.	2	2,000
Spedden Shipbuilding Co., Baltimore, Md.	5	1,644
Texas Co., Bath, Me.	2	.....
E. J. Tull, Pocomoke City, Md.	4	2,400
Union Iron Works Co., San Francisco, Cal.	3	1,000
Total	199	128,435

In the Southern district, which includes the Gulf Coast, there are 55 vessels of 72,406 gross tons under construction, while on the New England coast there are 54 vessels of 147,561 gross tons building.

Outside of the Puget Sound district, on the Pacific Coast, the output of the shipyards comprises 53 vessels of 224,730 gross tons.

It is interesting to note that nearly 75 percent of the tonnage building on the Great Lakes is suitable for ocean-going service, while over 90 percent of the tonnage building on the sea coast is suitable for the deep sea carrying trade.

Inter-Imperial Ship Lines Proposed for Great Britain

The report of the British Commission recommends the establishment of a permanent Imperial Development Board to carry out plans of co-ordination between the parts of the Empire for economic growth after the war. Among the developments that it strongly advocates is that of inter-Imperial communications in freight transportation, speedy mail and passenger service, and Imperial control of cable and telegraph systems. The Commission gathered much information about the practicalities of the subject that is very interesting.

Particularly interesting is the picture of future shipping and mail routes linking up widely separated parts of the British Empire and furnishing the trunk lines from which Empire trade to other countries may branch off. The Commission studied with experts in ship construction the economies of building big ships, and to make the use of big ships practical on routes best suited to connect the ports of the Empire, it calls attention to its belief that one of the first duties of the permanent Imperial Development Board will be to begin a comprehensive scheme of improvement of the harbors of England and the dependencies, so that the big ships may be accommodated at ports of call on routes mapped out. The Commission says:

"Both cheapness of transport and high speed are unobtainable except in vessels of great length and proportionate draft. Under present conditions such vessels are impractical, as the harbors and the waterways of the Empire will not admit them.

"To some extent these considerations have influenced the minds of shipowners, naval architects, and harbor authorities, but the improvement of isolated harbors is of little avail unless all the harbors on a given route are brought up approximately to the same level. Joint co-ordinated action is required. Individual disconnected improvement is of little use. It is, therefore, obvious that efforts should be made to correlate and develop the existing and future capacity of harbors on the great trade routes of the Empire."

The advantage to the United States of having its river and harbor improvements under the charge of Federal authority is recognized and the analogous advantage of an Imperial authority pointed out. The Commission finds that the most important harbors both on the Atlantic and Pacific coasts of this country and the Panama Canal have already been correlated in the way they recommend for the long trade routes around the world.

What is said about economic size of ships for this purpose is of value:

"Taking 28 feet 3 inches as the economic draft for a vessel 490 feet in length, it was found that this draft increased to 30 feet for a vessel 520 feet in length, to 33 feet for one 573 feet in length, to 34 feet for one 590 feet in length, and to 38 feet for one 660 feet, and so on."

The mechanical reasons for these economies are quoted from the British shipbuilding authority, Sir J. H. Biles, who says:

"The conclusion that unrestricted draft is necessary for economic transport can be arrived at from first principles. A vessel constructed of a depth sufficient to go to, say, 40 feet draft does not cost so very much more than a vessel of a depth constructed to go to 29 feet draft, whereas the increase in weight of cargo is the difference between the extreme draft of the vessel and the draft the vessel must have in order to float her hull, and machinery, and coal, and stores.

"Supposing two ships are constructed, the one of 29 feet draft and the other of 40, and in each case the draft necessary to float hull, machinery, etc., before paying cargo can be put in, is 23 feet. In the one case there is only 6 feet of draft available for paying cargo, whereas in the other case there is 17 feet. The weight of hull for the restricted draft vessel increases much more rapidly than the displacement. The beam cannot be increased in the same ratio as the length, or the stability conditions will be interfered with. Before a great length is reached the deadweight that can be carried no longer increases as the length of vessel increases, but begins to decrease. Further, the excessive proportion of breadth to draft in the large vessel of restricted draft is bad from the point of view of resistance and therefore the running costs, which depend on the power of the machinery, are considerably increased."

Following out this principle, Sir John Biles supplied various practical and very striking illustrations. He found that if draft were unrestricted the cost of transport steadily decreased with increase of length: thus a vessel 700 feet long, with proportionate draft, could transport goods on a 3,000-mile voyage at a speed of 14 knots 13 percent cheaper than a smaller vessel of 490 feet in length, while further increase in speed in the larger vessel would be less costly. He also found that increase in length is uneconomical unless accompanied by adequate draft; thus, with draft restricted to 23 feet 3 inches, the cost of transport per ton for a voyage of 3,000 miles by a vessel 700 feet in length would be 50 percent greater than if the same vessel had its full proportionate draft; in fact, increase of length without proportionate increase of draft not only does not diminish cost of transport, but actually increases it.

The Commission suggests that these proportions might be considerably modified through improvements in motive power, presumably through application of oil engines to big ships.

Largest American Marine Diesel Engine Installation Proves Successful

The largest Diesel engined motorship so far built in the United States is the twin-screw naval collier *Maumee,* of 14,500 tons displacement, propelled by two single-acting, two-cycle Diesel engines of 2,600 shaft horsepower each. The engines were built by the machinery division of the New York Navy Yard, Brooklyn, N. Y., in accordance with original designs secured from the Machinen Fabrik Augsberg, Nurnberg, Germany, through the New London Ship & Engine Company, Groton, Conn. Each set of engines has six cylinders with a diameter of 25.2 inches and a stroke of 37.37 inches. At a normal speed of 130 revolutions per minute the engines are designed to give the ship a speed of 14 knots.

Since the *Maumee* was completed last December the vessel has been in active service for five months, and during that time has made 18,000 miles without a hitch. The engines have proved very satisfactory in service, and have been ready to respond to any emergency. The only defect that has developed has been the cracking of some of the cylinder jackets, which is apparently due to lack of sufficient clearance between working liners and jackets. It is thought that additional clearance can readily be allowed and that when this is done the engines will be ready for any service.

The fuel economy is excellent, the consumption being less than one-half that required for the most economical steam plants. Ordinary Navy fuel oil is used. The con-

sumption is about .5 pound of oil per shaft horsepower for all purposes.

The engines handle very well, and as the *Maumee* is a vessel engaged in service that requires repeated going alongside of vessels, docks, etc., the handling requirements are particularly severe.

The overhaul and upkeep requirements have been very meager, and but for the cracked castings have been attended to for five months' continuous running by the ship's facilities. The cost of the upkeep is apparently considerably less than for a steam plant of the same power and similar service. Less operating personnel is also required.

The weight of the installation is about the same as for a triple-expansion reciprocating steam plant, but, owing to the fuel economy, about 7 percent additional cargo-carrying capacity is available.

The actual performance of the *Maumee's* engines has demonstrated that large Diesel engines present fewer difficulties in service than do small or medium installations, and there are no apparent reasons why the power per cylinder on the *Maumee* (about 500 horsepower) should not be doubled with entire success. This indicates that Diesel engines of 5,000 horsepower per engine are an entirely feasible proposition.

For cargo boats operating in localities where fuel oil is available, the Diesel engine admittedly has great advantages. The extra first cost can very likely be made up in the first year's operation. Certain special advantages of the Diesel installation may be mentioned, as follows:

(a) The engine is ready to move in a few minutes.

(b) Full power either ahead or backing is available any time.

(c) No smoke or cinders, hence extreme cleanliness can easily be maintained (a particular advantage for passenger ships).

(d) Regulation of speed is much easier and certain.

(e) All stand-by losses are eliminated. Fuel consumption begins and ceases with the movement of the engines.

Orders to Shipping Designed to Increase Safety of Life and Vessels in War Zones

Orders have been issued, effective May 12, by the Board of Supervising Inspectors, Steamboat Inspection Service of the Department of Commerce, by Gen. George Uhler, Supervising Inspector General, and approved by Secretary Redfield, providing for an increase in life saving and safety appliances and equipment to be carried by all vessels entering the war zone. These orders were prepared at the direction of Secretary Redfield, who had ascertained that of all the Americans who had lost their lives in the war zone only two have been killed by gunfire or like violent means.

According to these orders to the supervising inspectors of all districts, the capacity of lifeboats shall hereafter be 15 cubic feet for each person instead of 10 feet, as heretofore. This reduces the carrying capacity about one-third, allows more room and ample room for rowing operations.

Summary of New Orders

In addition to the equipment of lifeboats required by existing regulations, there shall be provided a hand pump for each boat with a plunger of not less than two inches in diameter and a discharge pipe of sufficient length to reach clear of the boat's side. This to render more effective the bailing of lifeboats. The food or provisions required to be carried in the lifeboats may be hard bread or the United States "emergency ration" in tins. Each ration is sufficient to maintain a grown man twenty-four hours. Food which produces unusual or immediate thirst, such as corned beef, salt fish and the like, will not under any circumstances be allowed. When hard bread is carried, there must be provided in addition at least ten tins of the emergency ration.

Lifeboats on cargo steamers shall be provided with a separate set of davits for each lifeboat. Additional davits to be installed must be of the mechanical type, to facilitate quick and safe launching. The old type of davits with "turning-out gear" are not classed as mechanical davits.

Lifeboats Required

Cargo vessels shall carry sufficient lifeboats based on the reduced capacity stated to accommodate every person on board and in addition shall carry a sufficient number of approved life rafts to accommodate at least 25 percent of the total number of persons on board.

Before entering the war zone all lifeboats and life rafts shall be cleared away and made ready for launching, and the master or officer in charge shall assure himself that all the required equipment is in the lifeboats and life rafts, in good order, and ready for immediate service. Steamers which are not equipped with mechanical davits shall have all lifeboats swung out (weather permitting) and ready for immediate launching before entering the war zone. Cargo vessels contracted for after May 1, 1917, and serving trades within the war zone, shall be equipped on each side with lifeboats of sufficient capacity to accommodate all persons on board, based on an allowance of 15 cubic feet per person, and in addition thereto shall be equipped with a sufficient number of approved life rafts to accommodate at least 25 percent of all persons on board.

Launching of Lifeboats

The board also suggests that as many, or nearly all, lives that have been lost from vessels after attack have been due in many instances to the fact that the boats have been launched while the ship had considerable way, either ahead or astern, and engineers have been compelled to abandon the engine room while the engines were still working, the bridge watch or master assure themselves, if possible, that the engines are at rest and the way off the vessel before the boats are launched.

It is also strongly recommended that, due to the possibility of boats on the weather side of the ship not being available, that the full lifeboat capacity on cargo ships be carried on each side, so that the full capacity may be available at all times.

Day and Night Watch

It is also strongly recommended that on all vessels entering the war zone or dangerous areas the passengers and crew be kept fully prepared day and night, so far as possible, for speedy and immediate disembarking or abandoning ship in case of an emergency, and that the crew be furnished with life preservers of such character as to allow the free use of the arms in rowing and boat launching. All should be warmly clad without unnecessary or hindering incumbrance.

The requirements and suggestions are asked to be met promptly and generously, and it is expected that all concerned will co-operate in making better and safer conditions in the navigation of dangerous areas. Local inspectors are told, however, not to unnecessarily delay vessels proceeding on their way to ports of the Allies if it is not possible to meet all these requirements previous to the appointed time of departure.

LETTERS TO THE EDITOR

Conversion of Sailing Vessels Into Power-Propelled Ships for Emergency Cargo Fleet

In the face of the most urgent necessity for power-propelled ships, it seems surprising that the responsible authorities entirely overlook the possibilities that can in short order be obtained from converting our large coastwise sail schooner fleet into steam- or motor-propelled craft. With a twin-screw arrangement the principal structural members of the sailship would remain intact, while the necessary structural alterations could readily be made in a thoroughly substantial and durable manner with very little loss of time.

For power plants the engines and boilers of the large tugboat fleets could readily be removed and quickly installed in the converted sailships.

This tugboat machinery ranges usually from 300 to 800 indicated horsepower and would in the twin arrangement furnish quite suitable power to ships from 180 to 240 feet long, enabling them to make from 9 to 12 knots speed. All cargo ships, of course, will have to be specially protected against U-boat attacks either by arming them or by providing naval convoys.

New York. THEODORE LUCAS.

Reliability of Large Diesel Engine-Driven Vessels Shown by Performance of Motorship Sebastian

The Diesel-driven motorship *Sebastian* (7,200 tons displacement) was placed in service at the end of last June, since when she has covered approximately 40,000 nautical miles at an average speed of almost 9 knots, without a single breakdown, cylinder crack, or piston crack, cylinder-head crack, crankshaft fracture, etc., although she has been worked in the heaviest of Atlantic winter weathers.

The total number of engine stops at sea (accessory adjustments only) in nearly ten months amount to four hours with one engine and five hours with the other engine, also six hours with one engine when salt water got into the lubricating oil and had to be cleaned out. The mileage covered would have been about 3,000 miles greater had she not been held up in England for fifteen days having certain alterations to her deck structure previous to her last recent voyage to New York.

Fuel consumption of the two main engines together has averaged under 6 tons (42 barrels) for 24 hours, with the engines averaging a fraction under 1,000 indicated horsepower *each* at 115 revolutions per minute. This figures out at 0.27 pound per indicated horsepower hour, or just over 0.4 pound per shaft horsepower. In her holds she carries 4,100 tons of cargo.

On the last voyage to an American port both her Diesel engines ran for sixteen days and nights without a single stop, voluntarily or otherwise, averaging 8.8 knots in most heavy seas and adverse winds.

In nearly ten months the main bearings have worn down 1/128th part of an inch. The crankpin bearings, although opened out for examination at regular periods, have only been readjusted once in ten months, the wear showing 0.2 millimeter. The crosshead bearings have been readjusted to 0.3 millimeter in the same period. Compressor piston rings are the same which came out with the ship, and show hardly any wear at all. A few of the main piston rings have been renewed, but this has been mostly due to breaking them when springing them off the pistons for cleaning purposes. The cooling pump valves are as good as the day they were put in, some ten months ago.

Furthermore, the Diesel engines, which were built by Werkspoor of Amsterdam, were not run or tested in the shops. They were built, sent to England in packing cases, and installed in the *Sebastian,* which was given a few hours' sea trial, and sent on her maiden voyage, arriving in New York in sixteen days.

The owners of the vessel are Lane & Macandrew, of London. All the engineers of this ship state that their work at sea is far less arduous than that aboard a steamer and that they have little to do other than watch the lubricating oil.

Diesel engines have enormous reserve emergency power, which can instantly be developed by increasing the pressure of the injection-air, and the chief engineer of the *Sebastian* considers that if chased by a submarine he could obtain for a few hours as much as 1,500 indicated horsepower per engine, although the builders' rating is 1,100 indicated horsepower at 130 revolutions per minute. Although passing through the war zone a motorship is nearly immune from submarine attacks because of the absence of smoke from her funnel, so that three miles away she is not visible to the periscope of a submarine in average weather, whereas the smoke of a steamer gives the U-boat about twenty miles' radius.

T. ORCHARD LISLE.

Diagonal Strapping in Large Wooden Ships

I have been exceedingly interested in reading Mr. William T. Donnelly's article on the "Problem of the Wooden Cargo Ship," published on page 206 of the May number. Because Mr. Donnelly invites criticism, I am sending you a copy of a letter which I have just been writing to the United States Shipping Board.

Mr. Donnelly has the right idea as to the proper distribution of material in the upper and lower members, or "booms," of the girder or truss which is the ship itself. His longitudinal bulkhead, if retained in his design, might be modified to advantage; shearing strains are best met by diagonal members. It is very important that a wooden ship should have transverse bulkheads, to prevent "racking" strains from changing the transverse shape of the ship, and if the character of the cargo (long sticks of timber, for example) make transverse bulkheads objectionable, then partial transverse bulkheads must be made use of, to secure the necessary strength.

Mr. Donnelly's bilges are not new, but they have appealed to me as the most unobjectionable way of getting round one difficulty at that place. If he will modify his design by incorporating diagonal planking, either inside or outside, I believe he will have a most excellent, strong and durable ship, so far as wear and tear go. You cannot build a durable ship out of green, unseasoned material, and he, in common with all those in any way connected with rush-order wooden ships, is going to suffer. I believe in steel for ships—not wood—under normal conditions, but if we are going to have wooden ships they should be built as intelligently as possible.

LETTER TO THE UNITED STATES SHIPPING BOARD

"Conceive a series of planks well put together to represent the longitudinal fastening of a ship, and another series laid across them to represent the transverse framing, with every plank fastened to every crossbeam by a through-bolt or nail; and then conceive every joint of these planks to be filled with hard stuff, like oakum, hammered into it with an iron wedge and mallet until the joint is hammered

quite hard and can hold no more, and the structure seems quite rigid—as rigid as we can conceive it, and for the moment it is as rigid as we do conceive it; but unluckily it will not stand so.

"Subject this structure to light strains it will remain riged, but subject it to such a strain as will slightly compress the longitudinal plank, and do this cornerwise alternately in opposite directions, and you will find that as you change the direction of the strain from one corner to the other askew each plank will move a little way along the other and return back again when the force is the other way. This goes on more and more as you repeat the operation, and this is exactly what does happen to the planks of a ship when she labors long and heavily over a head-sea. Likewise it is what does happen to the frame when she labors heavily in a cross-sea.

"To those heavy strains everything is found to yield a little; planks give by each moving a little along the other, bolts begin to widen their holes as the planks strain across them, first one way, then the other; the couples of the timbers begin to draw from their fastenings as the ship careens first on one side, then on the other. A friend of mine who made a voyage across the Atlantic in heavy weather in a very large wooden ship of weak construction used to watch carefully the edges of the planks opening and shutting as she went from the top to the hollow of a sea, and used to fill his tumbler by watching the opportunity when a joint near him opened and a jet of water passed in. I saw her when she returned from the voyage, and I was satisfied that the seams must have opened wide, for I saw the oakum calking hanging in festoons. She went another voyage and was never heard of again."

The foregoing was written by a famous naval architect, a vice-president of the Institution of Civil Engineers and also a vice-president of the Institution of Naval Architects, in the year 1865, when wooden shipbuilding was a highly developed art—now unfortunately a lost art. Sir Robert Seppings is usually credited with being the first to point out the necessity of providing diagonal strength, and back in the '50's of the last century the largest and best wooden ships were always built with "Seppings' diagonals," either in the shape of diagonally disposed timbers, wrought iron straps passing from wales to keel or diagonal planking combined with the longitudinal planking.

As early as 1847, when the keel of the *Powhatan* was laid at the Norfolk Navy Yard, the United States Navy Department was specifying for such vessels (she was 251 feet 6 inches long by 45 feet beam by 26 feet 6 inches deep) diagonal strapping, and every officer familiar with the history of our navy knows what a long and useful life this particular wooden-hull vessel enjoyed.

In 1849 Messrs. Bishop & Simonson built the *Ohio* (248 feet by 45½ feet by 24½ feet) for the Law Line and Smith & Dimon built the *Georgia* (255 feet by 49 feet by 25½ feet) for the same company. Both ships were diagonally braced with 3-inch round iron. The Collins Line steamers *Atlantic, Pacific, Arctic* and *Baltic* (282 feet by 45 feet by 24 feet and 32 feet) were built in 1850, the *Arctic* and *Atlantic* by William H. Brown and the *Pacific* and *Baltic* by Brown & Bell. All four ships were diagonally strapped both ways, each line of straps 4 feet from center to center. More than twenty years after the date of their launching the *Atlantic* and *Baltic* were carried on the books of the American Bureau of Shipping as successful sailing ships.

The same is true of the famous paddle steamship *Vanderbilt,* 320 feet by 48 feet 8 inches by 29 feet 8 inches, built in 1855. She was fitted with seven solid transverse bulkheads and was longitudinally and diagonally strapped. So late as 1879, as a sailing ship (called the *Three Brothers*) she was considered a strong and seaworthy vessel. The last wooden ship built for the Collins Line was the *Adriatic,* 351 feet by 50 feet by 33 feet 3 inches. She was diagonally strapped like the other Collins ships.

No account of well-built large wooden steamers would be complete that failed to include the large ships built for the Pacific Mail Steamship Company, the *Great Republic, Japan, China, Arizona, Alaska, Colorado, Constitution, Henry Chauncey,* and a dozen others, many of them built by William H. Webb and all of them thoroughly and properly diagonally strapped. Some of these ships were over 5,000 tons, Custom House measurement, more than 350 feet long and 50 feet beam with 32 feet depth of hold. These larger wooden ships were double diagonally strapped and double planked from keel to top of wales.

In 1865 the Royal Dockyards of Great Britain were building 50-gun wooden frigates 307 feet by 52 feet, whose frames were diagonally strapped with iron straps 6 inches wide by 1¼ inches thick. Those were the days when wooden shipbuilding was understood, and no first-class shipbuilder would have considered for one moment building large wooden vessels in which ample provision had not been made to meet twisting and wrenching strains.

Many large wooden schooners have recently been built on the Pacific Coast and elsewhere in which no suitable provision has been made to meet twisting strains. These vessels must inevitably prove dangerous, expensive investments, liable to start their seams leaking in heavy weather. No form of keelson construction, no matter how massive, can remedy this defect—even a longitudinal bulkhead running the whole length of the vessel is no solution of the problem.

Twisting strains such as a ship is subjected to when "wallowing" diagonally across seas is a skin strain and acts like all torsion strains along diagonal lines in the outer skin or planking. It must accordingly be met by diagonal skin strength. Vessels built on the "bread and butter" principle, as applied to their planking—two diagonal courses of planking under an outer fore and aft course of planking—are well calculated to meet these strains, and such vessels are certainly strong in this particular. Wooden vessels built without diagonal straps can be and have been cured by the application of an outer or inner course of diagonal planking. The British Royal Dockyards usually applied Sir Robert Seppings' diagonal trusses on the inside of the ship between the bilges and the shelf pieces of the lower hold.

Wooden ships can be built to stand any strain that ordinary sea service may impose, and that, too, when of much larger size than any yet constructed. The problem of the large wooden ship is a problem of fastenings. Transverse bulkheads are necessary, because no keelson the full length of the ship is capable of supporting its own weight without sagging, let alone keep the bottom of a ship from "coming up" or "going down." A "hog-frame," similar to those used so successfully in Sound and river steamboats, or a truss running fore and aft reaching from the top of the keel to the underside of an upper deck, running continuously for at least three-fifths of the ship's length, can without doubt prevent "hogging" or "sagging," if properly designed.

A ship is a hollow girder and most wooden ships have suffered in the past from lack of longitudinal strength in their decks. A wooden ship 420 feet long by 60 feet beam by 42 feet deep is a perfectly practical proposition; it is simply a question of locating the proper material in the proper way in the proper places.

New York. John L. Bogert.

Solving the Problem of the Ships*

World's Insatiable Demand for Ships Rapidly Developing America's Steel and Wooden Shipbuilding Resources

BY GEORGE J. BALDWIN †

SHIPS, and how to get them, fill more space in the newspapers of the whole world than any other topic except the war. In the absence of governmental restrictions, a shortage of ships can never be local. Just as the wind moves to fill in a low-pressure area, so have ships hastened to the places they were needed. The desire to avoid competition has been a great distributor of ocean tonnage. Ships have sought far and wide for new trades and new routes. Before the war all the world had its service; any port that could furnish a reasonable tonnage and a safe anchorage was a port of call.

Of late war law has superseded economic law. The fine balance has been destroyed. Governments have commandeered hundreds of vessels for use in the North Atlantic, and hundreds of others have been tempted into the danger zone by freight rates unequaled in modern times. Ships that have done a lifetime's service on the Pacific are now plying regularly between New York and Liverpool. From Quebec and Halifax cargo boats built for service on the Great Lakes are putting forth as ocean freighters. All the far-away places of the world have felt the strain and the call for ships is universal.

Demand for Ships Insatiable

Even if it were not for the submarine, the demand would be insatiable, for war is a gigantic consumer of material. But the submarine has had a very real effect on the situation. Although all estimates of tonnage destroyed are biased one way or the other, it is safe to say that the destruction of merchant tonnage alone has been 5,000,000 tons. That is equal to a tenth of the total world's ocean-going steam tonnage, or to a quarter of England's merchant marine. Apart from the huge losses of ships by the belligerents, are those of the neutral countries, all of which, without exception, have suffered. Spain, a maritime country, has lost a sixth of her tonnage; Holland also has been roughly handled, and Norway has lost more than 600,000 tons. The destruction of merchant shipping by submarines in February—and probably the same holds true of March—was more than the total ocean-going tonnage constructed in America in the entire year of 1916, and was almost equal to that completed in England the same year.

To make up these losses, building is going on rapidly wherever possible, but shortage of men or materials or both is prevalent in all shipbuilding countries. We do not know what England, the greatest shipbuilder, is doing, but the assumption is that she is hampered to an extent by naval work and by lack of engines and ship plates. At any rate, it is safe to say that the present world's production is far behind the destruction, and that even by the end of the year, when many organizations now being speeded up begin to contribute their full capacity—even then the world's shipyards will not be turning out steel ships much more than half as fast as submarines, mines and ordinary seafaring accidents have been destroying them these latter months.

It is a fortunate thing that the shipbuilding boom which was heralded all through last summer and autumn is now becoming a reality. There was great talk of new shipyards being started and of millions of tons of ships contracted for. But there is a vast difference in time between a shipbuilding company incorporated and capitalized all in good faith and a shipyard turning out ships. There is a vast difference, too, between a ship under contract and one in the water.

Wooden and Steel Shipbuilding Boom

Both the wooden and steel shipbuilding industries have, nevertheless, come ahead very well. In March there were thirty-four private steel shipyards in full operation; five of these were old yards reopened after long disuse and seven were entirely new enterprises. Plants for building steel ships are, of course, slower to put up than those for wooden vessels; but there have been some remarkable things done in that line. One shipyard on Puget Sound is turning out ships to-day on a piece of waterfront which fifteen months ago was nothing more than a meeting place for land and tide. There was not a stick standing nor a plank laid. And yet, by a rush of building a simple shipyard was thrown together, and by far-sighted and fortunate buying shipbuilding materials came on in their proper order, and within a little over a year four hulls were in the water. Two of these have gone to sea, completed ships, but the other two are waiting for engines and machinery.

Plants of this type are not full-fledged shipbuilding yards. They do nothing but assemble and are dependent upon distant engine works, boiler shops, and all manner of manufacturers, for everything that goes into their ships. A machine shop, three or four shipways, a railroad track crossing their ends transversely, and a cableway or overhead trolley to give service to each of the building ways—those are the essentials. They are simply outdoor places where ships can be put together, and as such they will serve their purpose very well in emergency times.

Obstacles to Expansion of Shipbuilding Industry

Many and varied are the factors which make expansion difficult. New organizations take superintendents, draftsmen and skilled workers from old ones, and munition plants bid against both for their men. Materials are a problem, too. The output of the steel mills is needed for so many things that a difficult question will arise as to which are the most urgent. The United States Steel Corporation has 11,700,000 tons of unfilled orders now against 4,250,000 tons two years ago. Similarly, in shipyards the world over, a dilemma exists, whether to rush fighting ships at the expense of merchant tonnage, or to give full recognition to the extreme importance of cargo carriers.

Despite all difficulties, progress is being made in American yards. A lot of last year's 600,000 tons production were lake ships unfit for ocean service, or car floats, or barges—types of little value in the present crisis. These have all been cleared away and now almost all ships on the ways or in preparation are ocean-cargo carriers. Even in the big yards on the Great Lakes sixty percent of the construction under way is being built for salt-water ser-

* From *The Americas*.
† Chairman of the Board, New York Shipbuilding Corporation.

vice and of the maximum size which can be taken through the Welland Canal.

Quite spontaneously wooden shipbuilding has been revived within the last year, and more than forty yards are building ocean-going ships of various types. The plants are scattered along both seaboards and the Gulf coast. Vessels of a thousand tons or more are being built in Maine, Massachusetts, Connecticut, Maryland, North Carolina, Georgia, Florida, Louisiana, Texas, California, Oregon and Washington. Four-masted auxiliary schooners of 2,000 or 3,000 tons deadweight capacity predominate, but ships as large as 3,500 tons are not uncommon, and a number of wooden steamers are in process of construction.

The speed with which a wooden shipbuilding yard can be gotten under way is amazing. More than one yard on the Coast has turned out its first ship six or seven months after the ground was cleared for the plant. Wooden ships like those being built at present and larger ones like those planned by the shipping board may prove to be of incalculable value in the present emergency.

Wooden Shipbuilding an Emergency Measure

How desperate is the need for ocean-going ships is shown by this move to resort to wooden ships. More than a generation ago the steel hull drove the wooden ship from the paths of commerce. Economy of operation did it and will do so again when the commercial life of the world returns to normal. Wooden ships are being built to-day with the knowledge that they must pay for themselves quickly and that within a few years they will be superseded by steel, as were their predecessors. But in the meantime they will serve an admirable purpose and their presence is justified economically as well as by war's demands as long as steel and labor command present prices.

The ocean-carrying trade need look for no let-up after the war, nor need shipbuilding companies fear slack times as far ahead as one can see. Regardless of the wants of a world that has been awakened from pole to pole, there will be two immediate tasks to perform. One is the carriage of all the expeditionary forces in Europe and Asia back to their homes in Canada, New Zealand, Australia, India, South Africa, Morocco. The other is restocking Europe, especially the Scandinavian and German countries. These are gigantic tasks, to be sure, and they will increase the call for ships and maintain freight rates for a considerable period, but when they are nearing completion the war's real effect upon commerce will begin to appear. An intensifying of demand, of production, of trade the world over will be seen.

Readjustment of World's Trade

The commercial relationships of the world have been shuffled like a deck of cards. Groups of nations have had to shift their trade interdependencies. New trade routes have come into being, new steamship lines have been established, new industries have sprung up. People have learned to accept strange goods from new purveyors. New implements are used in their work and new foods are found upon their tables. After the war not all these new things will remain, nor will commerce slip back into its old grooves entirely. There will be part of the new and part of the old. There will be, as never before, an educated demand for a great variety of commodities. More production and consumption and an intensified life for the entire world are assured.

The thought of the millions of men who have traveled far and seen and learned—men who would never have traveled at all but for the war—likens it to a stupendous World's Fair. And upon these men and the countries to which they return it will have an incalculable quickening effect. History has its parallel in the Crusades, which brought about the introduction of eastern culture into Europe and led to the Renaissance.

Russia in the Market for Ships

The awakening of Russia is in itself an event which contains untold possibilities. A vast territory hitherto locked up awaits development. The Russians are even now in the market for a large number of ships, and new steamship lines are planned after the war. Of these, the first to be established, according to the manager of the Baltic and White Sea Conference, are likely to be one from the Baltic to French and Italian ports, one from the Baltic to the White Sea, and one from Odessa to London, and another from Finland to America.

The whole world is planning steamship routes; and since America has the materials, it is and will be for years to come her task to build the ships.

Bulk Oil Steamship Wm. G. Warden

Third of Five Sister Ships of 15,000 Tons Deadweight Carrying Capacity Building at Newport News for Standard Oil Company

THE bulk oil steamship *Wm. G. Warden,* recently completed by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., for the Standard Oil Company of New Jersey, is the third of five duplicate vessels built and building for the same owners by this company. The preceding vessels of this type are the *Charles Pratt* and *H. H. Rogers.*

These vessels are by far the largest tankers yet constructed in the United States and are only slightly exceeded in size by a few tankers in the entire world. Some idea of their enormous capacity may be obtained from the fact that each vessel has a tank capacity for over 5,000,000 gallons of cargo oil. They are of the flush-deck type, with a total length of 517 feet, a beam of 68 feet, a depth to shelter deck of 38 feet, and have a deadweight carrying capacity when loaded to a draft of slightly over 27 feet of nearly 15,000 tons.

In common with modern practice in tank ships the propelling machinery is located aft, and, as is now becoming quite customary, they are twin screw vessels. Each vessel has ten main oil tanks, divided by an oil-tight centerline bulkhead into two compartments each, thus making twenty compartments. In addition, there are on each side of the vessel in the wings between the main

Tank Steamer *Wm. G. Warden.* Length, 517 Feet; Beam, 68 Feet; Depth to Shelter Deck, 38 Feet; Deadweight Capacity on 27-Foot Draft, 15,000 Tons

and upper decks six summer tanks, so that there is a total of thirty-two oil compartments, the combined capacity of which makes up the grand total of 5,000,000 gallons.

These tanks are so subdivided by cofferdams and pump room that three entirely different grades of oil may be carried at the same time without possibility of mixing. In all there are four complete atwartship cofferdams for the purpose of subdividing the oil tanks, to separate the latter from the general cargo space and the bunkers, and to separate the boiler room from the bunkers.

In addition to the tanks for the cargo oil the main bunkers are arranged so as to carry either fuel oil or coal, and there is also a deep tank forward divided into two compartments in which fuel oil may be carried, a total tank capacity of 475,000 gallons of fuel oil being provided, which is the equivalent of about 1,700 tons.

Coal bunkers are also provided for a total capacity of 2,000 tons, so that whether using oil or coal for fuel the vessel has capacity enough for at least forty days' steaming at full speed at sea, which will allow it to steam 10,000 miles without refueling.

The general appearance of the *Wm. G. Warden* is very much like that of the somewhat smaller tankers *John D. Archbold* and *John D. Rockefeller,* built by the Newport News Shipbuilding and Dry Dock Company for the same owners in 1914. The new vessel, however, has three masts, whereas the earlier ships were rigged with two only. The living accommodations are unusually complete. There are private baths for the captain, chief engineer, doctor and purser, as well as separate baths for the deck officers, engineers, petty officers, firemen and sailors. All living quarters are heated by steam. A hospital is one of the modern features, as is also a radio telegraph outfit. The total complement of the vessel will number about sixty-six.

The vessel was built under the special survey of Lloyd's Register for the highest classification awarded. A combined system of longitudinal and transverse framing is used in the construction, some of the features of which have not heretofore been used in any other vessel built in the United States, and this, coupled with the unusual feature of expansion trunks over each main oil tank of two full deck heights, makes this type of vessel of more than usual interest.

As heretofore mentioned, the vessel is provided with twin screws. The motive power consists of two sets of triple expansion engines with a total of 3,000 indicated horsepower, for which steam is furnished at a pressure of 215 pounds per square inch by three Scotch boilers, each 15 feet 9 inches diameter by 11 feet 6 inches long. The boilers are provided with a hot-air system of forced draft and are so equipped as to use either oil or coal for fuel. Each engine has its own auxiliaries, thus providing additional insurance against a possible breakdown of the entire propelling machinery. A large donkey boiler is fitted for supplying necessary steam for port use.

The appliances for handling cargo oil are necessarily quite elaborate. For this purpose there are two large

pumps installed in a separate pump room located near the middle of the oil tanks. These pumps are connected to the several oil tanks by two lines of piping for each of the three subdivisions into which the cargo oil may be graded, and so connected that the two kinds of oil may be loaded or discharged simultaneously. Valves are so fitted as to enable either pump to draw from any compartment and deliver into any of the other compartments, and also that either or both pumps can discharge separately to either or both sides of the vessel. Appliances are fitted for exhausting the oil vapor from the tanks and steam coils are also fitted in the tanks for heating the oil when necessary to facilitate pumping thick or heavy oils.

For lighting the vessel there are two generating sets of 20 kilowatts each, and in addition, an emergency set. The steering gear, windlass, winches, etc., are all steam driven and are all of high grade. A refrigerating plant with a capacity of 2 tons of ice per day is provided for cooling the ship's stores.

The entire equipment of the *Wm. G. Warden,* as well as its size, is such as to make it a notable addition to the American merchant marine. The vessel left Newport News on its maiden voyage on February 3, bound for the Mexican oil fields.

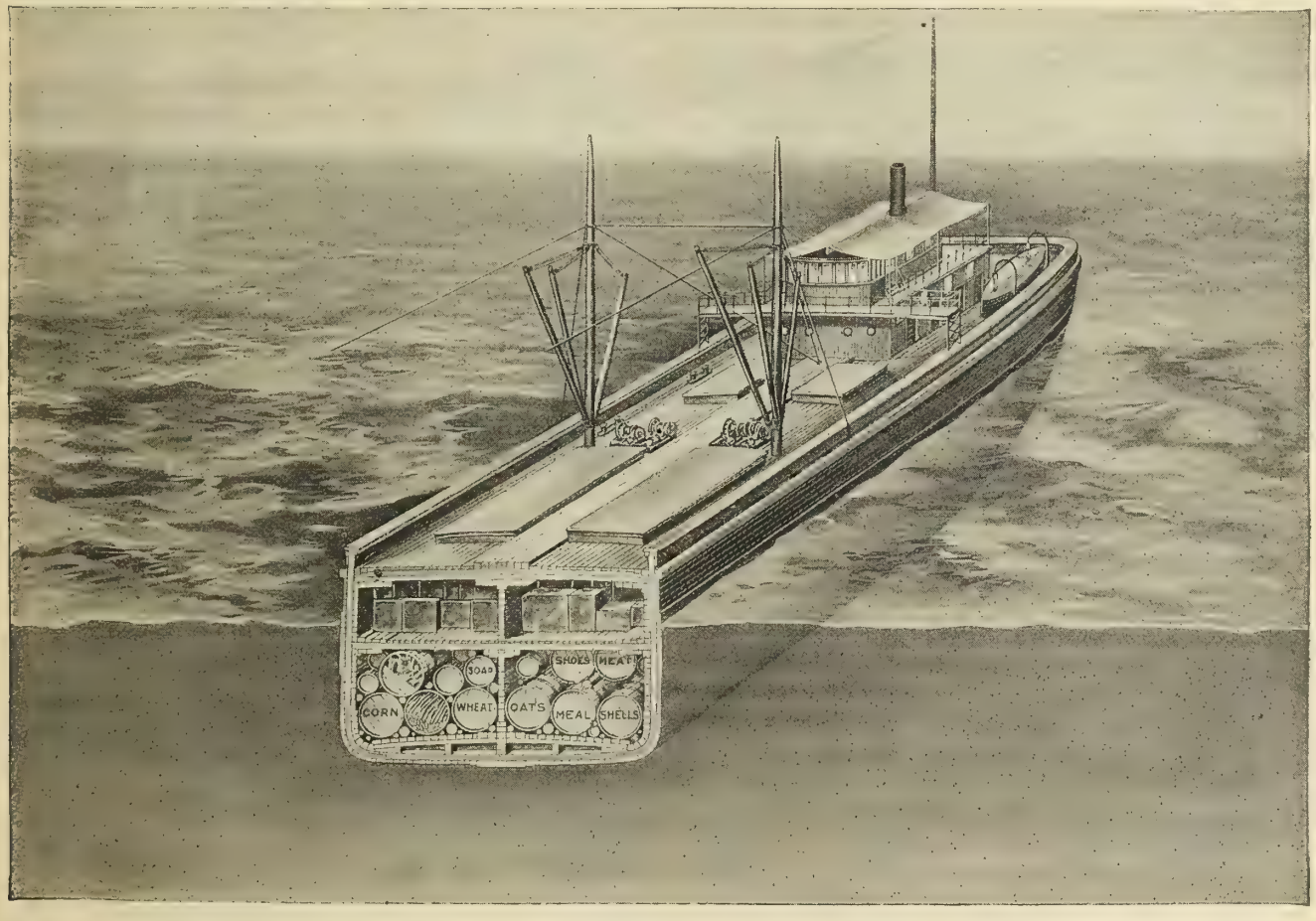
Wooden Ships and the Submarine Menace

Vessel and Cargo Made Unsinkable by Loading Cargo in Watertight Containers—Method Applicable to Steel Ships

BY WILLIAM T. DONNELLY

THE following is offered as additional information applying directly to the possibilities of the wooden ship, as illustrated and described on page 206 in the last number of MARINE ENGINEERING, and as a contribution to the problem of defense against the submarine.

The 350-foot wooden ship referred to, having a carrying capacity of 5,500 tons deadweight, would require for its construction 1,500,000 board feet of lumber. This lumber would weigh 40 pounds per cubic foot, or a total of 2,235 tons. Its volume would be 125,000 cubic feet; therefore if it was totally submerged it would displace this amount of water, which would weigh 3,570 tons, and it would then have a buoyancy or lifting power of 1,335 tons.



Section of Wooden Cargo Steamer of Donnelly Design, Showing Cargo Loaded in Watertight Containers, Making Ship and Cargo Unsinkable

There would be required in the construction of this hull metal fastenings of not more than 7 pounds per cubic foot, or 390 tons.

In case the machinery for this boat were the smaller type of semi-Diesel engines, furnishing electricity to electric motors, the total weight of propelling machinery would be not more than 200 tons (see page 211, May issue). The weight of the deck equipment for handling cargo would be approximately 50 tons, and the forward gear for handling anchors, etc., 45 tons, or a total of 685 tons.

Two hundred and fifty tons of fuel oil would have a specific gravity slightly less than water, and for itself would not require any support. If contained in steel tanks, they would have a sufficient extra capacity beyond that required for the oil to float themselves. From this it will be seen that a wooden ship, fully equipped, without cargo, would have a reserve buoyancy of at least 650 tons, and could be waterlogged but not sunk.

Cargo Loaded in Watertight Containers

To make the ship safe, loaded, it is only necessary to place the cargo in watertight containers, each of which in itself has a displacement greater than its own weight (see illustration), or, when the nature of the goods is such that the specific gravity is less than water, it is only necessary to waterproof the package or case.

For carrying grain, sections of large wooden pipe 10 feet in diameter would be built up within the cargo space of the vessel, and then filled with grain. Each pipe or barrel would be separately sealed and of ample strength to resist water pressure from the outside.

A careful analysis of this problem shows that there would be required for a cargo of grain 1,920 lineal feet of 10 feet inside diameter wooden pipe, which would have a weight of 500 pounds per running foot. This pipe would occupy or displace 168,960 cubic feet, corresponding to a buoyancy of 4,830 tons. It would have a capacity for 150,000 cubic feet of grain, which at 48 pounds per cubic foot would weigh 3,200 tons. The weight of the pipe itself would be 430 tons. The difference between this weight and 4,830 tons would give a margin of buoyancy for this cargo of 1,200 tons, which, added to 650 tons net buoyancy for the ship itself, would make a total net buoyancy of ship and cargo of 1,850 tons.

The cargo of grain within these pipes at 60 pounds per bushel would amount to 119,500 bushels. This could be increased by closing in the space between the cylinders and filling with grain. These spaces could be readily waterproofed. This arrangement would increase the cargo by 45,000 bushels and the reserve buoyancy by 400 tons, and the total cargo of grain would be 164,500 bushels.

Ship Safe with All Compartments Flooded

The foregoing calculation is based upon the specific gravity alone; in other words, upon a condition wherein water could enter freely every compartment of the ship, which in all probability would never occur from submarine attack, as it is well known that a torpedo causes destruction within a radius not greater than 25 feet from the point of attack.

The value of the foregoing cargo of grain at prices now prevailing, $3.47 (13/7) per bushel, New York, would be $570,000 (£117,000), and the first cost of installing wood pipe containers, as per estimate of reliable parties, not more than $40,000 (£8,200). It will be understood that other cargo can be stored in some of these containers for a return voyage. Any class of cargo can be carried, the only provision being that the weight shall be kept within the requirement that the total weight shall not exceed the displacement of the cylinder.

It is not at all necessary that all cargo should be placed within the cylinders, for if the cylinders are carried empty and the bulk cargo placed in the hold below or around them, the buoyancy of the cylinders will maintain the ship afloat when water enters.

The foregoing method of rendering ships unsinkable does not depend upon any theory or device, but simply upon the well-known properties of materials, and the division and storing of cargo in a scientific manner. While the illustration of a grain cargo has been taken, ammunition or any mixed cargo can be treated in the same way. Attention is called to the fact that very little reduction from the full cargo is brought about by this method of loading.

Method Applicable to Steel Ships

While the foregoing method of loading applies with very great advantage to the wooden ship, it is in a lesser degree applicable to the steel ship, but in the case of a steel ship of equal size, she must start off with a deadweight handicap of 3,100 tons, which, owing to the fact that it is entirely made up of iron having a specific gravity of 7.85, will be reduced only approximately one-eighth of its weight by total submergence; in other words, the fully equipped steel ship has a force of 2,700 tons dragging her down when water enters, whereas a similar size of wooden ship has a net buoyancy of 650 tons supporting her when full of water.

By subdividing the cargo carriers and making them watertight, it is not only possible to support the deadweight of the steel ship, but a very considerable amount of cargo. This is in a much larger proportion as the size of ships increase, and is a very practical method as applied to a steel cargo ship of approximately 10,000 tons deadweight carrying capacity.

Heine Boilers for First Ships of New United States Emergency Fleet

Contracts for the first ships of the new emergency fleet being built by the United States Shipping Board under the supervision of Major-General Goethals were recently awarded to the Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal. This contract calls for eight steel vessels of 8,800 tons deadweight capacity, 426 feet long and 54 feet beam. Each of these vessels will be equipped with four standard Heine marine oil-fired boilers built for 200 pounds working pressure, each boiler containing 2,900 square feet of heating surface. The negotiations for the boilers, 32 units in all, were consummated by Mr. Samuel L. Naphtaly, vice-president of the shipbuilding company, and Mr. E. C. Meyer, president, and Mr. Paul H. Brangs, director of the Heine Safety Boiler Company.

Omission

In the article entitled "Oxy-Acetylene and Oxy-Hydrogen Welding and Cutting in the Marine Field," published on page 182 of our April issue, the name of the author was unfortunately omitted. This article was contributed by Mr. Henry Cave, director of technical research of the Davis-Bournonville Company, Jersey City, N. J. Mr. Cave has been intimately connected with the oxy-acetylene industry for many years and has been one of the most frequent and authoritative contributors to the literature and information on this subject. The "Navy Type Plants" and the radiagraph described in the article were developed by the Davis-Bournonville Company.

Standardization as Applied to the Machinery for Cargo Boats*

Possibilities of Standardized Manufacture as Applied to Cargo Boat Engines, Boilers and Auxiliaries—Divergence of Existing Rules

BY D. B. MORISON

AN experiment in the standardization of cargo ship machinery has recently been made by the North-East Coast Institution of Engineers and Shipbuilders. The members and council have commenced on very conservative lines by preparing a guidance specification for triple expansion engines for cargo boats, based on the best practice of the various specialized builders on the Coast. It is proposed to begin on simple lines for this year, but an annual revision will be made in order that the specification may be gradually extended and kept thoroughly up to date with a view to securing the maximum rate of progress in technical advance and commanding the confidence and promoting the ultimate interests of all concerned, viz., of the engine builder, the shipbuilder and the shipowner. Other specifications on similar lines are to be prepared for quadruple engines, geared turbines, and internal combustion engines.

Progressive Improvement Necessary in Standardization

Assuming that in the general problem of standardization this guidance specification of the North-East Coast Institution represents the best now obtainable, the next step is to provide means whereby there shall be progressive improvement by continuous investigation and research, supported by organized and collective practical experience. With regard to the latter it is not sufficient that the engine builder gets rid of his goods on the day of the trial trip. There should be some system of co-operation between the engine builder and shipowner whereby the general results in coal economy and costs for repairs over a prolonged period, certainly beyond the usual six months' guarantee, are recorded and rendered available. In order to secure the funds for carrying out this scheme it has been suggested that the cargo boat engine builders of the North-East Coast should be invited to adopt the specifications at a small fee per horsepower. As the money so collected would be entirely devoted to promoting the progress of the associated industry, it is hoped and expected that there will be an enthusiastic response.

Standardizing Auxiliaries

In the matter of auxiliaries the research committee appointed by the Council of the North-East Coast Institution will exhaustively test approved apparatus connected with a marine installation and publish in their Transactions the results obtained. This will secure a reliable means of ascertaining the true performance of any apparatus so tested, and as the results will carry the hall-mark of the Institution for accuracy, the value of the scheme to the industry generally is obvious.

In the matter of boilers and shafting, complete standardization of marine machinery is blocked because the Board of Trade, Lloyd's Registry, and the British Corporation issue independent rules which are based on physical facts as a constant and individual opinion as a variable. Just a very little co-operation and mutual sympathy would enable all the existing differences to be adjusted, to the great advantage of the many industries involved. Manufacturers generally anticipate with confidence that these authorities will do their part in promoting national progress by working together with this object.

When Lloyd's Registry revised their rules some years ago they requested the assistance of a committee of experts selected by the leading marine engineering institutions. This committee has been very successful, as the various members, all of whom occupy leading positions in the several shipyards and engine works, are in such direct touch with practice that their experience establishes mutual confidence, to the great benefit of all concerned.

Committee of Experts for Revising Rules

A similar committee of experts was appointed by these institutions about the same time, with the object of providing a means whereby the many irritating disputes and misunderstandings which so frequently arose some years ago between the Board of Trade and the manufacturers could be overcome, the collective technical experience of the members being available in the event of new rules being issued or old rules revised. Each member of the committee was prominently associated with a shipbuilding yard or a marine engineering works, and all gave their services with enthusiasm, although often at great personal inconvenience. In any progressive country on the face of this earth except our own such a committee would have been welcomed, and its expert capacity officially recognized and utilized to the fullest extent for the common good; but the traditional antagonism to innovation, no matter how desirable, has prevailed. For twenty years this committee has given of its best to the cause of progress. It has never received adequate recognition or encouragement from the Department of State it was appointed to assist. It is gratifying to record, however, that a serious attempt is now being made to devise some mode of procedure for making full use of the existence of this committee in the national interests.

Standardization Applied to Boilers

Assuming the various surveys decide to harmonize their rules so that standard design, scantlings, and physical properties of material may prevail throughout the range of cylindrical boilers as now supplied to cargo boats, the economic effect on the manufacture of the material and the building of the boilers would be very pronounced. It would at once be possible to prepare a series of standard designs, with accompanying specifications for plates, furnaces, tubes, stays, rivets, etc. The steel manufacturer could estimate the probable demand, produce in bulk and give immediate delivery. The boiler builder would be freed from the delays arising from the preparation and submission of designs, and would simply order from the scheduled list—receive the goods exactly when required, and proceed with the manufacture with an economic continuity hitherto impossible.

* Paper read at the Institution of Naval Architects, London, March 28.

The following are examples of divergence between the surveys:

1. For a single-ended boiler 15 feet 6 inches in mean diameter, 11 feet 6 inches long, 180 pounds working pressure, thickness of shell 1 13/32, tensile 28½ tons to 32½ tons per square inch, diameter of rivets 1 3/32, pitch of rivets 9½.

Working Pressure of Shell

		Pounds
Board of Trade	=	183
Lloyd's Registry	=	210½
British Corporation	=	204½

2. For the working pressure for a suspension furnace 3 feet 10 inches inside diameter, ⅝ inch thick:

		Pounds
Board of Trade	=	185.3
Lloyd's Registry	=	200.5
British Corporation	=	196.5

An examination of the tables of pressure for these furnaces reveals to the curious that for thickness below 9/16 inch the Board of Trade allows a greater working pressure, the thinner the furnace, than Lloyds, and for furnaces over 9/16 inches thick Lloyds allow a greater working pressure, the thicker the furnace, than the Board of Trade. Arbitrary requirements also often involve unnecessary cost, as, for example, limitation by the Board of Trade of rivet pitch to 10½ inches, with a tensile of rivets of from 27 tons to 32 tons, necessitates an increase in shell tensile for large boilers, for which abnormal extras have to be paid to the steel makers. A brilliant example of what can be achieved by well-directed collective effort is the standardizing of stationary boilers in the United States of America by a committee of experts appointed by the American Institution of Mechanical Engineers. In this connection the following extract from a speech by the late president of the Board of Trade would seem to be appropriate: "It will, in fact, be apparent to all close observers that a country which fails to regulate and foster its industries in the national interest cannot in the nature of things long survive the rivalry of another country where the industries are so regulated and fostered."

Diameter of Engine Shafting

The only detail of the engines proper affected by the surveys is the shafting, and the following is an analysis for a set of triple expansion engines with cylinders 25 inches, 41 inches, 68 inches, by 48-inch stroke and 180-pound boiler pressure.

Diameter of Crank and Thrust Shafts

Board of Trade	=	12.76
Lloyd's	=	13.32
British Corporation	=	13.08

Diameter of Tunnel Shaft

Board of Trade	=	12.12
Lloyd's	=	12.69
British Corporation	=	12.42

In determining the diameter of propeller shafts, each of the three surveys adopts a different basis. Lloyds and the British Corporation consider the diameter of the propeller —the British Corporation the block coefficient of displacement of the vessel, while the Board of Trade considers neither. Assuming a propeller diameter of 17 feet 6 inches and a block coefficient of displacement of 0.78, at four-fifths molded depth, diameter of propeller shaft:

Board of Trade	=	13.47
Lloyd's	=	14.29
British Corporation	=	14.67

That is to say, a shaft to the Board of Trade requirements would be deemed 22 percent too weak by the British Corporation and 16 percent too weak by Lloyds. In practice the shafting of a cargo boat is practically never made to the rules of the Board of Trade, as when the machinery is built to the Board of Trade survey it is invariably associated with either Lloyds or the British Corporation. If, therefore, these two surveys could see eye to eye and bring their shafting rules into line, a great advance could be made towards completely standardizing the reciprocating engines of a cargo boat.

With the advent of the geared turbine and its probable extended use in the near future, it might reasonably have been expected that the various surveys would at least have formulated rules on a common basis. Such, unfortunately, is not the case. Lloyds and the British Corporation adopt shaft horsepower, the Board of Trade indicated horsepower, Lloyd's rule giving the larger shaft. This state of affairs is perhaps not surprising in view of the fact that aloofness has hitherto been a national characteristic. Force of circumstances will compel us to modify this attitude, and to recognize that friendly co-operation will be the factor which will determine whether we sink or swim in the coming great race for industrial supremacy.

To obtain all that is commercially possible from standardized production it is necessary to manufacture continuously a given article in the best way by the best means at the best speed, whereby the efficiency of each factor is unity. The greater the number manufactured, the less becomes the percentage of attendant expenses. Therefore, in cases where the value of the article is considerable and the demand great, the commercial success attainable may be phenomenal. Quantity is a controlling factor in all cases, so that maximum success in the standardization of marine engines can only be obtained by the co-operation of the greatest number of builders.

Merely as an illustrative example let us consider the position on the North-East Coast. The various engineers who specialized in cargo boat machinery produce collectively, say, 200 sets of reciprocating engines per annum. The following is a rough classification of the parts of the main engines only:

Main Divisions of Engines

1.	Cylinders—	
	Cylinders	600
	Covers	600
	Liners	200
	Pistons	600
	Valves	600
2.	Columns—	
	Columns	1,200
	Guide plates	600
	Guide bars	1,200
3.	Bedplate—	
	Bedplate	200
	Bearings and keeps	1,200
	M. B. bolts	2,400
	M. B. nuts	4,800
4.	Main Forgings—	
	Piston rods	600
	Connecting rods	600
	Main bolts	1,200
	Cranks	600
5.	Valve Gear—	
	Eccentrics	1,200
	Eccentric straps and rods	1,200
	Radius links	600
	Drag links	1,200
	Reversing shaft	200
6.	Condenser—	
	Body	200
	Doors	400
	Water head	200
	Tube plates	400
	Tubes	250,000
	Ferrules	500,000

7. Pumps—

Air pump	200
Circulating pump	200
Feed pump	400
Bilge pump	400
Sanitary pump	200
Levers, etc.	400
Drag links	800

Taking the steel forgings, and adding the thrust, tunnel and propeller shafts, the approximate total weight would be about 14,000 tons. If this amount were concentrated at a convenient center the steel cast, the ingots forged and the forgings rough turned, and if the works were of such size that this demand was only a portion of its output, then the cost of production would be so low as to enable the engine builders to buy cheaper and to sell cheaper. The destination of these forgings for machining would depend on available facilities and transport, the object being a continuity of operation under the most favorable conditions possible. The heavy castings would be produced from standard patterns, all prepared in consultation with the iron foundry management, and the design being standard, the foundry management could with confidence provide the best labor-saving tackle. When delivered to the engine works the castings would be dimensioned by means of standard apparatus and machined from continuous supply. The tens of thousands of engine valves, fittings and other details would be classified and manufactured in bulk in specially equipped departments in the best ways, by the best means and at a cost quite unapproachable by present methods.

In cases where an aggregation of parts is not sufficient to secure the benefits of production in bulk those parts should be purchased from manufacturers whose business it is to produce such parts. For example, take condenser ferrules. A condenser ferrule machine can produce 400 per hour. Even if the yearly demand were half a million, the machine would produce them in about 1,200 hours, or, say, 24 working weeks, thereby being operated at half its capacity. Complete standardized production of ferrules and similar details would involve the use of the greatest number of automatic machines that could be supervised by one skilled operator and one or more unskilled assistants. One skilled machine setter and three unskilled assistants could probably manage up to 20 automatics. Therefore, the difference between one machine working half its time with one operator and 20 machines working continuously with four operators is an indication of the possible savings by organized manufacture in bulk.

Take as another example the large bolts such as are required for main bearings, piston rods and connecting rods, and which would aggregate about 10,000 per annum. So great a number of practically similar articles would admit of the purchase of special turret lathes capable of finishing bolts up to 5-inch diameter, with provision for completing all operations from the first rough cut to the final screw cutting and finishing, and if the number of machines were adjusted to maintain their full capacity the cost of production would again be very favorable.

These few examples indicate the possibilities of standardized manufacture as applied to cargo boat engines. The system is co-operative and is the direct antithesis in its inception and in its results to the destructive competition which has been so rampant and ruinous in past years. In manufacture the day of conservative and scattered individual effort is over—it leads to certain ruin. Success lies only in concentration by collective effort and the pooling of individual interests for the common good. The industrial problems of the future must be faced, and faced quickly—moreover, they must be solved, and solved quickly. The onus of responsibility falls primarily on capital, in the provision of standardized organization, direction and equipment whereby the best is accurately determined and the best is progressively maintained; thereafter capital and labor must co-operate in standardizing rapid production, so that good general trade may be promoted by steady employment at high wages, to the lasting benefit of the industries concerned and the general welfare of the entire community.

Standardized Geared Turbines for Cargo and Passenger Steamships

Marine Turbines with Reduction Gears Aggregating More than 150,000 Horsepower Now Building by De Laval Steam Turbine Company

THE saving in weight, fuel and expense of upkeep, including attendance, achieved by the use of geared steam turbines for ship propulsion is becoming generally recognized. Over 200 power units of this type are at present under contract or construction in this country. We are informed by the De Laval Steam Turbine Company, of Trenton, N. J., to whom we are indebted for the accompanying illustrations, that over 150,000 horsepower of geared marine turbines are now going through its shops alone.

The weight of a geared marine turbine, including valves, coupling, etc., is only 40 to 50 pounds per shaft horsepower, as against about twice that weight for a reciprocating engine. The saving in space will be apparent from the illustrations. Fig. 1 shows a unit rated at 1,500 horsepower. The turbine is designed to use steam at 180 to 200 pounds pressure, exhausting to 28-inch vacuum pressure and consists of one velocity-stage wheel and seven stages with separate reversing element. The reversing wheels are capable of developing 60 percent of the forward torque. The normal turbine speed is 4,000 revolutions per minute and the propeller speed 90 revolutions per minute.

The complete unit, as shown in the illustration, weighs only about 65,000 pounds and occupies a space of 21 feet long by 9 feet wide and 8 feet 8 inches high; that is, 164 cubic feet, or equivalent to about 9 horsepower per cubic foot. The De Laval geared turbine unit shown in Fig. 2 is rated at 2,500 horsepower, but is only about a foot and a half longer and two feet wider and one and a half foot less in height, so that it occupies altogether about 177 cubic feet, giving 14 horsepower per cubic foot.

A saving of 10 to 20 percent is made in fuel consumption by the geared turbine over the reciprocating engine

drive even in the largest vessels. As compared with the reciprocating engine the geared turbine gives a better overall plant efficiency, due principally to two factors. One of these is its ability to utilize higher superheat and vacuum than can reciprocating engines. The gain in turbine efficiency from superheat is about 1 percent for each 10 degrees F., and from vacuum about 8 percent between 28 and 29 inches, referred to a 30-inch barometer. The reciprocating engine, on the other hand, experiences difficulty with high superheats and benefits little from any increase of vacuum above 28 inches because of the limited

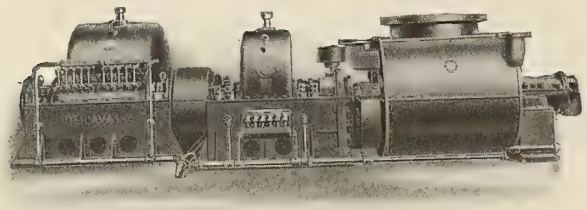


Fig. 1.—Geared Turbine Unit, Rated at 1,500 Horsepower; Weight, 65,000 Pounds

size of the low-pressure cylinder and of the valve ports. In fact, too high a vacuum results in loss from the low temperature of the condensate.

The geared turbine set shown in Fig. 3 is designed to use steam at 265-pound pressure and 130 degrees F. superheat, exhausting to a minimum of 28 inches vacuum. The turbine is of the compound type; that is, arranged on two shafts. This type of turbine is supplied where the highest efficiency is desired. It also gives the advantage of duplicate turbines in case of accident. The gears are of the standard De Laval type with rigid casings to hold the pinion and gear shafts in fixed and permanent alinement.

The turbines run at 2,400 revolutions per minute and the speed of the gears and of the propellers is 110 revolutions per minute. The ships in which the units are to be installed are twin-screw vessels, 480 feet long, 60 feet molded breadth and 12,500 tons deadweight, designed for a speed of 14 knots.

Further fuel economies are realized in turbine-driven vessels by properly correlating the auxiliaries with the

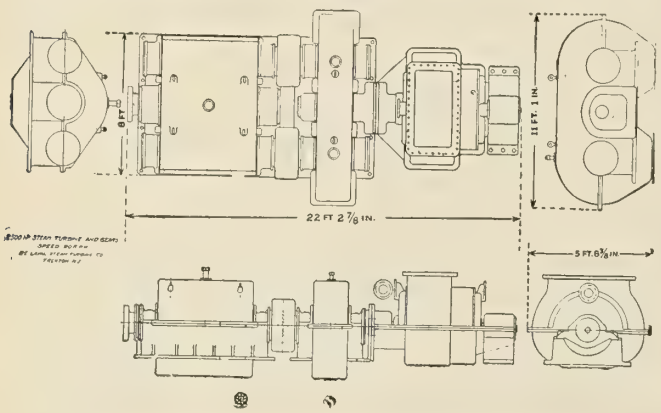


Fig. 2.—2,500-Horsepower Geared Turbine Unit

main unit. The steam consumption of auxiliaries sometimes exceeds 15 percent of the total amount of steam produced by the boilers, even when running at full power, and in the majority of ships exceeds the amount of steam which can be used for feed heating. By diverting the surplus or excess auxiliary exhaust to an intermediate stage in the main turbine this steam can be made to produce in the latter at least half as much power as it would have produced had it been received directly from the boiler.

In reciprocating engine power plants, on the other hand, surplus auxiliary exhaust is frequently bled directly to the condenser in order to save the condensate, but with a total loss of the heat of the steam. Even where it is led to the intermediate receiver of a reciprocating engine it cannot be used with much more than half the benefit gained by introducing it into an intermediate stage of a steam turbine.

The economy of the steam turbine is better maintained in service than is that of the reciprocating engine, as

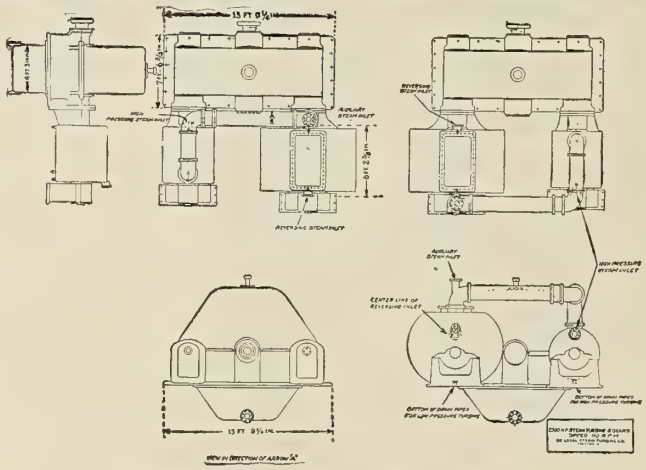


Fig. 3.—Compound Geared Turbine Unit

there are fewer parts to deteriorate and cause loss of efficiency. The turbine also shows a saving in operating expense, due to the fewer moving parts and the ease with which they are lubricated and adjusted. The oiling system is automatic and much simpler than the oiling system of a reciprocating engine. No oilers are required for the turbines.

There is no need of constant attention and frequent overhauling, such as the reboring of cylinders, refitting of valves and piston rings and adjustment of complicated valve gear. There are no packings, except the simple ones about the shaft. The consumption of oil is only trifling in comparison with that of a reciprocating plant;

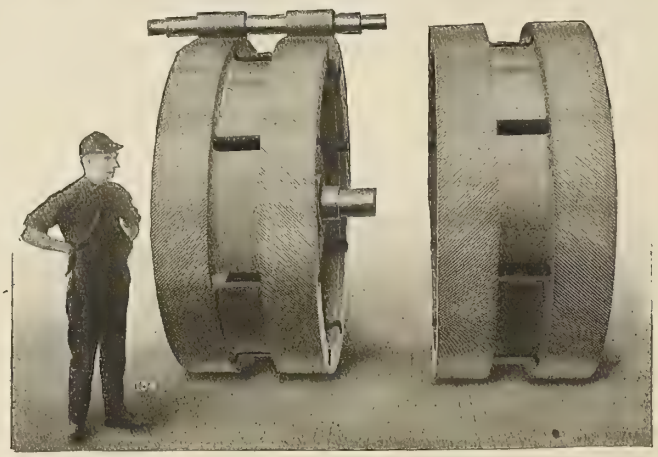
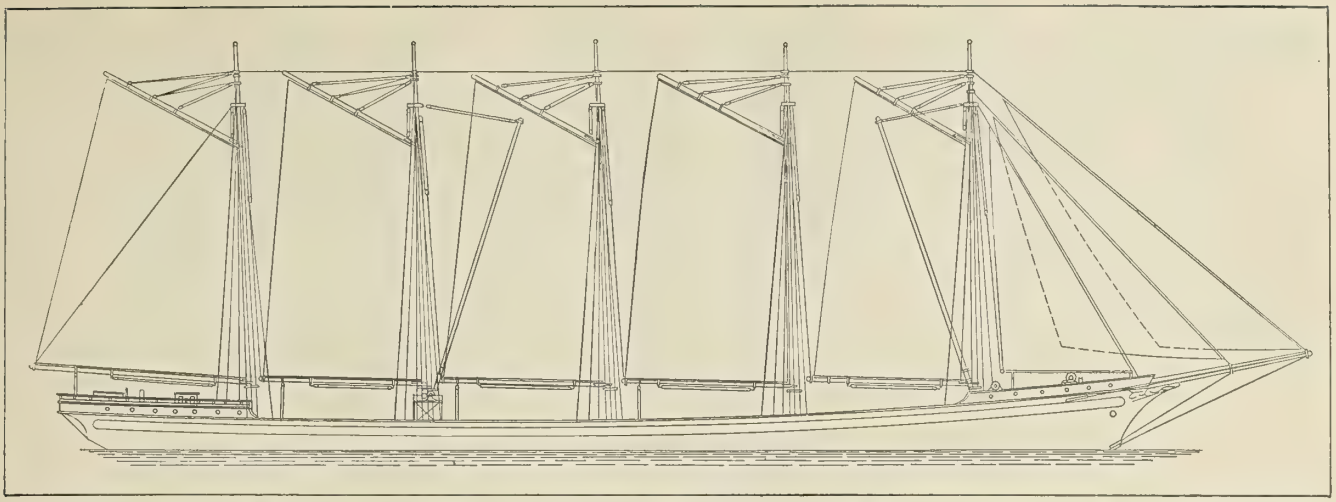


Fig. 4.—De Laval Gears for U. S. Battleship *Idaho*

there is no expense to correspond to the cylinder oil required by the latter. This fact is also of significance as regards the operation of the boilers.

The fewer number of working parts and general greater simplicity of the geared turbine as compared with other prime movers naturally leads to less expense for personnel in the engine room; that is, fewer oilers, machinists and men for general attendance and repair work.



Five-Mast Bald Head Schooner, Fitted With Diesel Auxiliary Power. Length, 260 Feet; Molded Depth, 21 Feet; Deadweight Carrying Capacity, 2,700 Tons

Wooden Auxiliary Schooner

Description of 260-Foot Vessel of 2,700 Tons Deadweight Capacity—Auxiliary Power Installed

CAPTAIN O. D. TREIBOR, general manager of the National Shipbuilding Company, Seattle, Wash., has prepared plans of a standard type fore-and-aft, five-mast, bald-headed schooner with clipper bow, overhanging transom stern, topgallant forecastle, full-poop with half deck forward of same which has a deadweight carrying capacity of about 2,700 tons. While designed as a wooden sailing schooner, the vessel is equipped with auxiliary power. Space is left at the after end of the hold for an engine room arranged to accommodate two propelling engines of the internal combustion type of 180 horsepower each.

The vessel, which is built for the purpose of carrying lumber both above deck and below deck, and other bulk cargoes, is 260 feet long overall, 225 feet long on the keel, 44 feet beam molded, 21 feet depth molded and 19 feet depth of hold. In the opinion of the designer, a vessel of this size is as large a vessel as should be built of wood in order to insure durability, economy in repairs and ease of operation.

General Arrangement

The main deck runs the full length of the vessel and a line of 'tween deck beams is fitted in the hold. A watertight bulkhead is fitted forward of the machinery space and there are three main cargo hatches about 14 by 21 feet and one smaller hatch. Cargo ports are also placed in the bow on both sides. The forecastle contains the galley, crew's messroom, storeroom, lamp rack, toilet room with bath and other necessary accommodations. The poop contains the main cabin, pantry, five staterooms, including stateroom for the master with private cabin adjoining, together with toilet room, baths, storeroom, etc.

The scantlings of the vessel provide for ample strength and rigidity, the keel is 20 inches by 20 inches; the stem is sided 20 inches and molded 30 inches, while the stern post is 20 inches by 24 inches. The frames are built up of double timbers spaced 30 inches centers on the keel. They are molded 26 inches at the keel tapered to 20 inches at the lower turn of the bilge, 17 inches at the upper turn of the bilge, 12 inches at the main deck and 9 inches at the rail. The floors are sided 12 inches. In way of the raised forecastle, the frames are carried up double to the rail. In way of bulwarks, a single timber is carried up from the main deck to the rail and in way of the poop deck the double timber is carried up from the main deck to the under side of the covering board. The main keelson is 20 inches by 20 inches and the rider keelsons also 20 inches by 20 inches. Three sister keelsons of the same size are fitted on each side of the main keelson.

Ceiling and Planking

At the turn of the bilge there are five strakes of ceiling 14 inches by 14 inches and three strakes 12 inches by 12 inches beveled to fit the curve of the frame. Above the bilge the ceiling is 10 inches thick. All of the ceiling is carried the full thickness for three-fifths the vessel's length amidships, the thickness at the ends being not less than four-fifths the thickness amidships.

The planking varies according to the following schedule: garboard strake, 9 inches by 18 inches; strake next to the garboard, 7 inches by 18 inches; bottom planking, 5 inches thick; wales, 6¾ inches thick and top side planking 6 inches thick. The full thickness of the planking is carried for three-fifths of the vessel's length amidships and from there is reduced to not less than 4¼ inches at the hood end.

The main deck beams, spaced 4 feet centers, are molded 15 inches at the centerline, 13 inches at the ends and sprung with a crown of 8 inches in 44 feet. The 'tween-deck beams are spaced in alternate beams except at the hatches. They are sided 16 inches and molded 15 inches at the center, 12 inches at the sides and are sprung with a crown of 5 inches in 44 feet.

The engine room bulkhead consists of two thicknesses of 3-inch by 5-inch fir slow kiln dried and planked diagonally with a layer of ship felt between. The bulkhead is stiffened with studs 6 inches by 12 inches spaced 4 feet centers on the after side. In the engine room suitable foundations are provided for twin screw engines and all

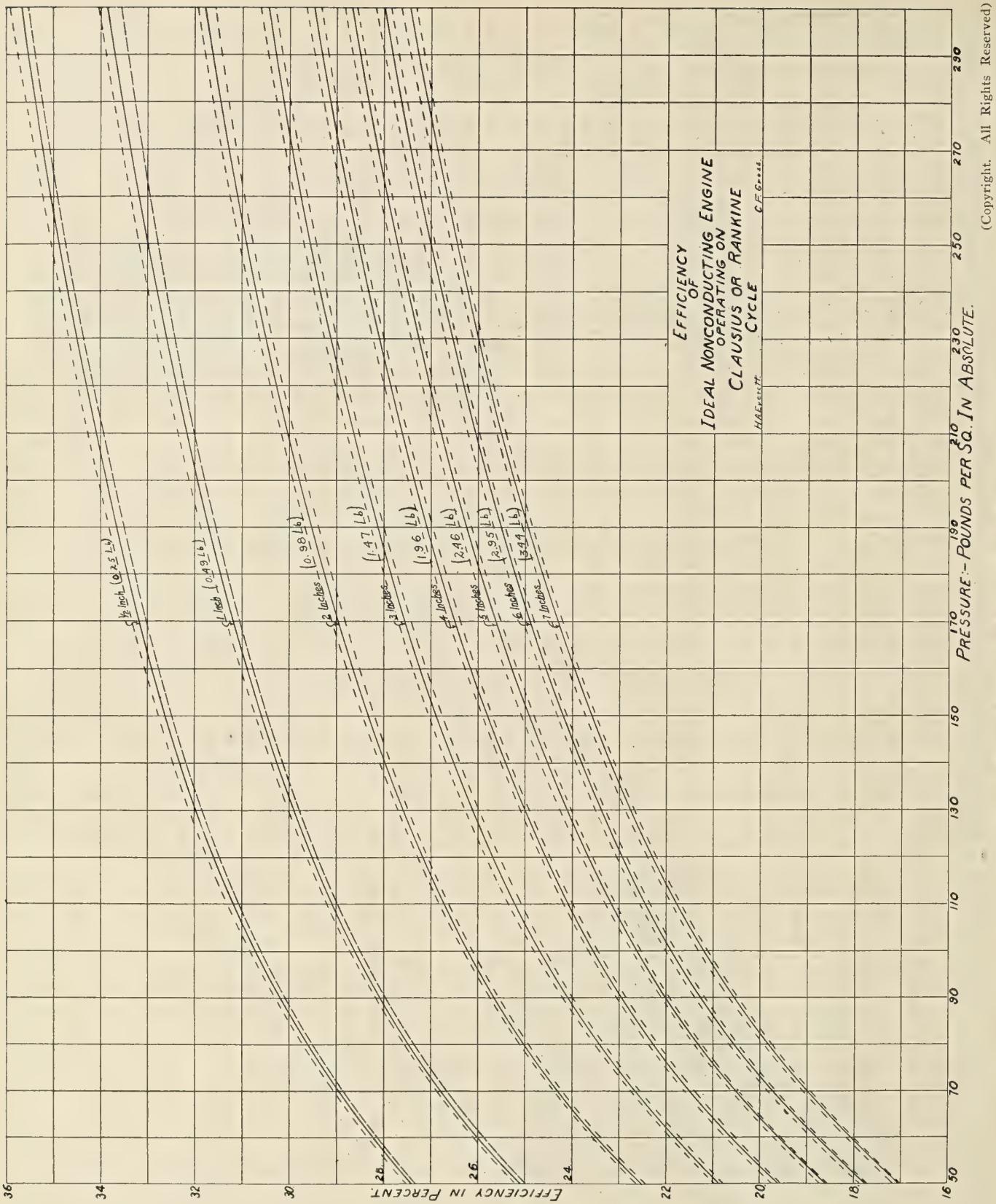


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Chart Giving Thermal Efficiency of Ideal Steam Engine (Rankine Cycle)

auxiliaries, tanks, storage batteries, etc. Fuel tanks of 1,000 barrels' capacity, built of 5/16-inch steel, are installed, as well as water tanks of 10,000 gallons' capacity, built of ¼-inch steel.

In addition to the propelling and auxiliary machinery, six cargo winches are fitted of the single-drum, two-gypsy, solid-link reversing type with cylinders 6 inches by 8 inches. On the forecastle an anchor windlass is fitted and also a 125-horsepower boiler, which is connected to all the winches and windlasses.

The name of the Brown Portable Elevator Company, Chicago, Ill., Harwood Frost, president, has been changed to the Brown Portable Conveying Machinery Company.

Chart Giving Thermal Efficiency of the Ideal Steam Engine (Rankine Cycle)

Efficiencies Plotted on Initial Pressures with Allowances for 50 Degrees F. Superheat and 5 Percent Moisture

BY H. A. EVERETT AND C. F. GROSS

THE efficiency of the ideal steam engine (working on the Rankine or Clausius cycle), which transforms all the heat available between its admission and exhaust into work, is expressed by

$$\text{Efficiency} = \frac{H_{\text{initial}} - H_{\text{exhaust}}}{H_{\text{initial}} - q_{\text{exhaust}}},$$

where H = heat contents and q = heat of the liquid.

To minimize the labor of looking up in the Steam Tables the values for a specific problem and the subsequent calculations, the chart on page 258 has been prepared, using eight accurately computed points to define each curve.

The abscissæ are the initial pressures (absolute), the ordinates are the efficiencies, and a single curve is drawn for each final or back pressure (absolute). The dotted lines lying just above and below the full lines give the values when the initial steam has 50 degrees (F.) superheat or 5 percent moisture (priming) respectively.

Problem I.—Find the thermal efficiency of the ideal engine using dry saturated steam at 175.3 pounds per square inch (gage) and exhausting to a vacuum of 27 inches mercury. Barometer = 30 inches.

Absolute initial pressure = 175.3 + 14.7 = 190 pounds per square inch.

Absolute back pressure = 30 inches — 27 inches = 3 inches.

For these data the efficiency is, from the chart, 28.1 percent.

Problem II.—A turbine takes dry saturated steam at 235.8 pounds per square inch (gage). Vacuum = 28 inches. Barometer = 29 inches. What is the Rankine efficiency?

Absolute initial pressure = 235.8 × 14.2 = 250 pounds per square inch.

Absolute back pressure = 29 inches — 28 inches = 1 inch.

From chart efficiency is 33 percent.

Problem III.—Same as No. 1 except steam has an initial quality of 95 percent (or priming of 5 percent). Efficiency = 28.0 percent.

Problem IV.—Same as No. II, except steam has an initial superheat of 50 degrees F. Efficiency = 33.2 percent.

Marine Applications of Reduction Gears of Floating Frame Type*

Characteristics and Advantages of Floating Frame Reduction Gears —Installations on Oil Tanker and Twin Screw Passenger Steamship

BY JOHN H. MACALPINE

THE bearings of a pinion and gear are, in most machines, supported very rigidly in a heavy framework or bed-plate. Such gears will here be referred to as "rigid gears." Reduction gears designed thus had been considerably experimented with to transmit the power of the turbine, but before Admiral Melville and the author took the question up in 1904 the solution of the problem of gearing for the turbine seems to have been despaired of except for very small powers.

Assuming that the teeth could be cut almost perfectly in a modern gear-cutting machine, it appeared evident to us that one important condition was left which, for the best result, it was essential to remove—the slightest error of alinement of the pinion, which is long in proportion to its diameter, would produce great inequality of distribution of pressure along the teeth. The method we adopted for freeing the design from delicacy of alinement was very simple. It consisted in mounting the pinion bearings in a very stiff frame, supported near the middle of its length by the bedplate, but (where the teeth are not in mesh) very free to move about an axis transverse to the axes of the gear and pinion. Thus the exact position of the pinion axis at any time is in part determined by the interaction of the teeth. Great equality of distribution of tooth pressure results.

The most important conclusions regarding the floating frame reduction gear are:

1. A floating frame gear will operate perfectly with the pinion sensibly out of line, and therefore the great difficulty of rigid gears—bad distribution of tooth pressure from minute errors of alinement—vanishes.

2. That the floating frame corrects from one-half to two-thirds of the effect of torsional yield of the pinion.

3. That the performance of gears of any design should be judged by the value of the "power constant"‡ it will safely bear.

4. From published data for rigid gears, and from those given here for floating frame gears, it is clear that, as anticipated, the power constant at which the gears are usually run is much higher in the case of floating frame gears than of rigid gears.

The power constant for rigid gears appears usually to be not greater than 2, while 3.5 and 4 are perfectly safe values

‡ $$\text{Power constant} = \frac{1000\ P}{D^3\ R},$$

where P = horsepower transmitted.
D = the diameter of pinion in inches.
R = revolutions per minute of pinion.

* Paper read at the Institution of Naval Architects, March 29, 1917.

for floating frame gears. Indeed, in the 12-hour, full-power trial of the United States collier *Neptune* the average power constant was 5.22. It has been in service for over one and a half years, and is frequently used at full power.

5. Comparing gears of different types, with a given ratio of reduction, a rise in the safe power constant quickly reduces the weight per horsepower. The higher power constant of the floating frame gear effects a marked reduction of weight over the rigid gear. Or, for the same weight of machinery, a greater ratio of reduction may be effected, allowing of a slower rotation and higher efficiency of propeller, or of a faster, smaller and more efficient turbine.

These are the principal conclusions, although there are others of some importance and many details to which I do not refer here.

I will now describe two marine installations: the first of a slow oil-tank, single-screw steamship, with double reduction; the second, a faster passenger and freight twin-screw steamer with single reduction.

Installation on Oil Tanker

Oil Tank Steamship.—This ship is being built by the Chester Shipbuilding Company, Limited. It is one of 45 freight ships of about the same power for which the Westinghouse Machine Company are building duplicate or nearly duplicate machinery.

Length	401 feet
Beam	54 feet
Draft	25 feet 9 inches
Displacement	12,650 tons
Cargo capacity	9,000 tons
Full speed, loaded	11.5 knots
Full power	2,900 shaft horsepower
Turbines	3,860 revolutions per minute
Propeller	75 revolutions per minute

There is a cross-compound turbine, the high-pressure and low-pressure parts of each actuating a separate single-pinion, first reduction gear which reduce the revolutions per minute from 3,860 to 483. There is one second reduction gear with two pinions, each first reduction gear actuating one of these, and the large gear driving the propeller shaft at 75 revolutions per minute. The turbines are aft of the gears. This arrangement allows the propeller shaft to be drawn inboard without disturbing the turbines or gears.

The ahead high pressure turbine is composed of a two-row, high pressure, impulse wheel followed by reaction blading carried on a drum. The ahead low pressure turbine has only reaction blading. Each of these turbine casings contains an astern turbine consisting of a two-row impulse wheel. The high pressure and low pressure turbines are usually operated as a cross-compound turbine; or, by suitable pipe and valve connections, either ahead or astern turbine elements can be operated singly and exhaust direct to the condenser, in case of emergency. The astern turbines can develop over 60 percent of the full ahead power with the same flow of steam.

With dry saturated steam of 180 pounds per square inch at the high pressure inlet and 28.5 inches vacuum (30 inches barometer), the guaranteed consumption of the turbines is 11.50 pounds of water per shaft horsepower hour.

	First Reduction Gear	Second Reduction Gear
Power per pinion.....(horsepower)	1,450	1,450
Pitch diameter of pinion....(inches)	5.114	10.228
Revolutions per minute of pinion....	3,860	483
Power constant	2.81	2.81

These gears are standard, designed for a maximum rating of 3,400 horsepower, with a power constant of 3.3.

The lubricating oil is pumped from a drain tank in the bottom of the ship by a rotary pump, which discharges it into an overhead gravity tank (fitted with strainers) at a height which will give a pressure of about 5 pounds per square inch to the oil at the discharge to the bearings and teeth. After leaving the gravity tank it passes through a surface water cooler and thence discharges to the sides of the bearings, where the bearing pressure is zero, and to the teeth as they are coming into mesh, so that it cannot be thrown out by the high centrifugal forces. If the level of the oil in the gravity tank should fall a short distance, still leaving a full supply for 10 or 15 minutes, an electric bell rings, warning the engineer to start an auxiliary oil pump. When the turbines are running slowly or stopped the oil is circulated by this pump.

The condenser circulating pump is driven by a geared turbine. The vacuum in the condenser is maintained by a Westinghouse Leblanc air ejector, and the condensate removed by a turbine-driven centrifugal pump. The former weighs 108 pounds and the latter 740 pounds. They replace an air pump of many times their weight.

The weight of the foregoing installation is 75 tons. This covers from the main turbine throttle and governor valve to the condenser, inclusive; also the thrust block and reduction gears (but no shafting), circulating pump, with turbine and its gear, air ejector, condensate pump, auxiliary oil pump, gravity oil tank, oil piping, and cooler.

Application to Twin Screw Passenger Steamer

S.S. Maui.—This twin screw ship is being built by the Union Iron Works, San Francisco, for the Matson Navigation Company. It will carry passengers and freight between San Francisco and the Hawaiian Islands.

Length over all	501 feet
Breadth, molded	58 feet
Draft	29 feet 11 inches
Displacement	17,500 tons
Full speed, loaded	17.5 knots
Full power	12,500 shaft horsepower
Turbines, high pressure and low pressure	2,120 revolutions per minute
Propellers	133 revolutions per minute

The turbines are cross-compound, reversible, and similar to those in the oil tank steamer. To conform to the limitations of the engine room the high pressure turbine actuates a pinion almost on top of the gear. Running either ahead or astern the high pressure turbines may be used alone, exhausting direct to the condenser, and the astern turbines can transmit 60 percent of full ahead power.

The steam pressure at the high pressure turbine inlet is 225 pounds per square inch with 50 degrees F. superheat. The contracted vacuum is 28.5 inches (30 inches barometer). Under these conditions the following performance is guaranteed:

Total S. H. P.	R. P. M. Propellers	Steam Per S. H. P. Hour for Turbines
10,000	125	11
8,500	120	10.7

There is only a single reduction from each turbine to the propeller.

Maximum power per pinion.....(horsepower)	3,125
Pitch diameter of pinion.....(inches)	7.794
Revolutions per minute of pinion.....	2,120
Power constant	3.113

The lubricating system and auxiliaries are of the same type as those for the oil tank steamer.

The weight of this installation, including the same parts as for the oil tank steamer, except the condensers, oil pipes and gravity oil tank, is 204 tons.

The introduction of the floating frame has been much accelerated during the last five or six months. There are in operation 102 gears, with a total of 126,442 horsepower; and on order 155 gears, with a total of 611,727 horsepower.

Besides the turbines and gears for land work and for the 45 freight ships and the *Maui*, the Westinghouse Machine Company are building the gears and, in all but two cases, the turbines for six warships, including a United States scout cruiser of 90,000 horsepower and a battleship for a foreign government of 88,000 horsepower. Indeed, principally to cope with this work the Westinghouse Electric Company, who have acquired the Westinghouse Machine Company, have begun to build, near Philadelphia, Pa., works which will be several times the size of their present extensive plant.

Simplicity of Adjustment of Gear

The simplicity of adjustment of the gear and pinion is remarkable. The pinion is placed in the floating frame and, by means of two gages supplied with each gear, the distances of the centers of gear and pinion at the forward and aft ends of the floating frame are made equal; the holes for the bolts holding down the floating frame are then reamed. There is no scraping of bearings to bring the axes accurately into one plane and secure bearing all along the tooth face, as must be done with a rigid gear. The action of the teeth will do that, and, as the theory shows, however the bearings wear or alter under stress, good distribution of pressure along the teeth will be maintained. The gear is then run, usually under quite a light load, and the hard-bearing spots, if any, scraped. The work is then complete.

If the floating frame functions as stated, the wear on the teeth should be extremely small. A remarkable proof of this was given last year from the operation of the first floating frame gear installed, that at the Commonwealth Steel Company, Granite City, Ill. This had not nearly so high a power constant as is now used, but it was reported that the maximum load reached 140 percent of its rating, under which condition the power constant is 1.68. It was started on March 31, 1911, and, after running for 10 months night and day, five days per week, the load averaging 85 percent of its rating, the tool marks were still visible on the teeth. Mr. K. S. Howard, the chief engineer, has informed the author that this gear was last inspected on April 30, 1916, when they found the *scraper* marks still visible on the gear teeth. Originally these were of imperceptible depth. The driving face of the pinion teeth had taken on a very high polish and the gear was as quiet as at first. This is after more than five years of service. He further reports that since installation it has operated 24 hours per day, six days per week, with loads varying from 50 to 125 percent of rating, the average being close to full load, and he sees no reason why it should not operate satisfactorily for an indefinite period. There have been no repairs. The only discrepancy in the report is that, apparently, in the busier times of the last few years the gear has had to work under a greater average load and for one extra day in the week.

Maintenance Costs Reduced to Minimum

Again, there is a 1,000-kilowatt gear guaranteed for 25 percent overload, at the San Diego Electric Railway Company's plant in California, which has been running 19 hours per day for five years. The superintendent of motive power states that it shows no sign of wear and that there has been no maintenance cost whatever. Similarly, two 5,500-horsepower, single-pinion gears of the Cleveland Electric Illuminating Company have been in operation for four years, giving no trouble and without wear. These results are not exceptions; they are almost invariable, showing the great safety of the device in spite of frequent high power constants. A further proof of the entire absence of point contact of the teeth is that chrome nickel has never been used for the pinions, as has frequently been done for rigid gears. Nickel steel has been used twice, to meet the physical characteristics required by the United States Government; but now these requirements have been changed and the pinions are always forged of a good quality of mild carbon steel.

Relative Failure of the Marine Diesel Engine*

Success is one of those human qualities to which it is rarely possible to assign an absolute value, and in engineering progress we might almost say that there are no such things as failure and success, but only stepping stones. When, therefore, we speak of the relative failure of the marine Diesel engine, it will be understood that the phrase "relative success" would be almost as appropriate. We have to look at the matter from the point of view of how much was expected from the Diesel type in the past; how few, comparatively speaking, of those expectations have been realized, and try and imagine what progress is to be expected in the future.

We can recall the time when the Diesel engine first came to be talked about; when it was anticipated by some that its progress would be so rapid as to leave no room for any other type. And truly, if the overwhelming superiority in fuel economy had not been attended by corresponding disadvantages, there was no reason why these high expectations should not have been realized. It took about a decade for the land type Diesel to get through the period of its infantile troubles, and this type naturally had to be perfected before attention could be turned to the marine type.

We do not propose now to enter upon the history of the marine Diesel engine—the various "stepping stones" in the development of the type have been from time to time described and illustrated in our pages—but rapidly casting our mind's eye over the experience gained in the last ten years, we are forced to the conclusion that the progress has been in the direction of perfection of detail and increase of reliability, rather than in any big advance in the sphere of its application.

Broadly speaking, the marine Diesel is limited to two types—the high speed, which has its main application in submarines, and the low speed, which has been successfully applied to the ocean tramp. Of the former type it would be inadvisable to speak at length, but the limitations of the size of the high-speed Diesel were pointed out in a paper read by Lieut.-Commander Anstey at the Institution of Naval Architects eight years ago, and experience since has confirmed the conclusions arrived at in that paper. Speed of revolution, on which low weight per horsepower mainly depends, cannot be maintained as the size of the cylinder is increased, with the result that bigger powered units must be heavier, or else the increase of power must be obtained by the multiplication of cylinders.

In the type which has been developed for the tramp, weight is not a primary consideration, and here the limiting condition has been the size of cylinder. We have heard of experiments being made with very large cylinders of the order of 1,000 horsepower, but so far the results have been maintained in reserve. We are not handling an ordinary engineering problem when we come to deal with Diesel engine cylinders of, say, 50-inch diameter, which may be exposed to a pressure of anything up to 900 pounds or 1,000 pounds per square inch. The problem is more one for a gun designer than a marine engineer, and one begins to wonder whether the game is worth the candle. If we arrived at such dimensions, it is fairly ob-

* From *The Engineer*.

vious that the weight of the installation would probably exceed that of a steam set of equal power. Not that that would be a great consideration if counterbalancing gains could be proved, but experience has shown that the larger the unit the less the balance of advantage of the Diesel engine over steam, and there must be some point at which the credit balance disappears entirely.

An argument with some who have not studied the question is that improvements are daily being made, and will still further be made, which will make further progress possible. The answer is, of course, that it is not a question of making improvements; it is that we are up against mechanical principles and laws which cannot be altered. In all questions of engineering progress similar conditions may arise. Take, for example, the question of obtaining a high speed in a vessel of a given size. Imagine that we had got to the point of progress in the design of the hulls represented, say, by an old-type, 30-knot destroyer, but imagine at the same time that our steam machinery was at the stage represented by the compound engine at 90 pounds pressure, and that the lightest form of boiler known was the locomotive type. Imagine such machinery installed in our boat, and we might probably reach 20 knots. We trace our steam machinery through its subsequent development, changing it from time to time in accordance with the improvements, but keeping the boat the same. Through all these changes we will suppose we have had an ideal in view, to obtain, say, 33 knots. We arrive eventually at the highest power we can possibly cram into the boat, and we find we can just reach 30 knots, and it has been the last two knots which have taken all the trouble to get. Probably, by making supreme sacrifices in weight, we could even get another knot, but is it worth it? The time has now come when it is necessary to abandon an unpractical though possible solution, and to find a way round it. We have imagined the hull unchanged through all this previous development; now we turn our attention to it and we find that, by lengthening the ship and increasing the displacement, we can practically begin in speed where we left off in the old type. The curve of horsepower and speed which was getting so steep as to be almost vertical at the top has, under the newer conditions, a reasonable slope, and shows us that we can still get an increase of speed with a reasonable addition of horsepower. This question of the relation of speed of vessel, and power required to produce it, is a parable of a large number of problems of engineering progress. Development begins on certain lines and proceeds satisfactorily up to a certain point; beyond that progress becomes increasingly difficult, until at last the advance made is not commensurate with the expenditure of energy required.

Some such situation has now arrived with the marine Diesel engine. Engines up to 250 horsepower per cylinder, and up to eight cylinders on one shaft, are now fairly common. The difficulties increase progressively as we pass the 250-horsepower mark, and at some point—we hesitate to give an exact figure—it will not be worth while to attempt more power per cylinder. The system then breaks down unless a larger number of cylinders is accepted, and shipowners and engineers will be reluctant to accept this solution, the former on account of cost and space, and the latter on account of complication. The problem of complication is one that has to be got round if further advance is to be made. Now, it is well to fix in our minds what we mean by complication. Multiplication of parts does not in itself constitute complication. The steam turbine, for example, has an enormously larger number of parts than a reciprocating engine, considering each blade as a separate part. It is when those parts are dependent upon one another, or form working "pairs" liable to get out of adjustment, that the objection arises to their multiplication. If it were possible to simplify valves and their gears, which are the principle sources of trouble and anxiety, we could go on multiplying small cylinders almost indefinitely to obtain the desired power. In any case, some break from the reciprocating type is necessary if we are to see high speed, or even moderate speed, vessels propelled by internal combustion engines.

Marine Engine Chart*

Graphical Determination of Dimensions of Triple-Expansion Marine Engines

By T. Addison

THE accompanying chart or, rather, series of charts, was designed to facilitate in the determination of the general dimensions of marine engines of the inverted triple-expansion type, for ordinary cargo vessels up to 6,000 tons displacement, having a maximum speed of 12 knots. The general dimensions include diameters of each of the three cylinders, stroke and diameter of crankshaft. Other dimensions depending upon cylinder diameters can be included as required.

Let us take a particular example so as to become familiar with the usage of this chart, and let us assume that the above dimensions are required for a vessel having a displacement of 4,500 tons, an Admiralty constant of 240, and that it is desired to drive this ship at 10.5 knots.

From the Admiralty formula:

$$I.H.P. = \frac{(D)^{\frac{2}{3}} V^3}{C} \qquad (1)$$

Where $I.H.P.$ = indicated horsepower,
D = displacement of vessel, in tons,
V = speed in knots,
and C = admiralty coefficient.

We have

$$I.H.P. = \frac{(4{,}500)^{\frac{2}{3}} \times (10.5)^3}{240}$$

Therefore,

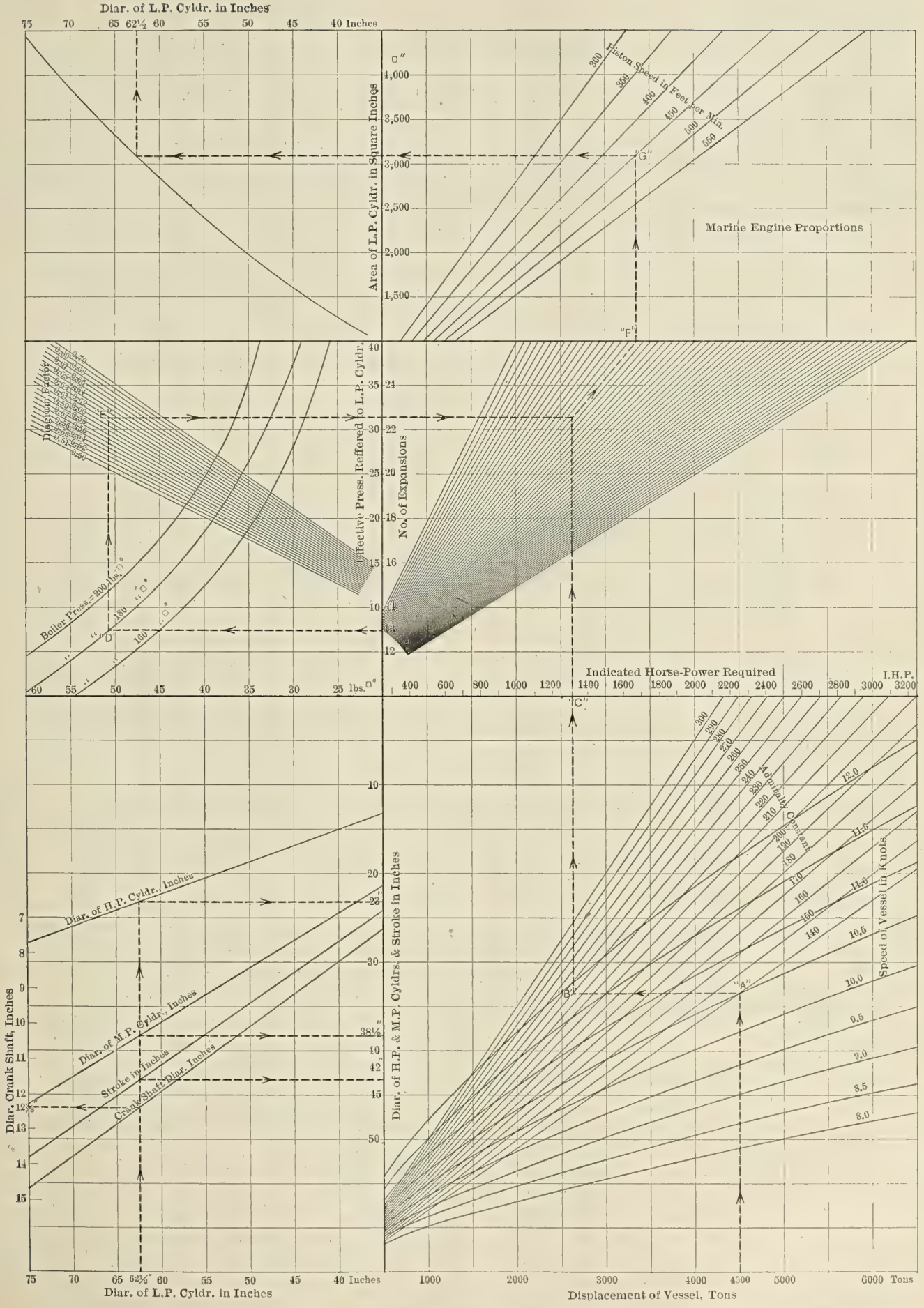
$$\log I.H.P. = \tfrac{2}{3} \log 4500 + 3 \log 10.5 - \log 240,$$
$$= 2.4355 + 3.0636 - 2.3809,$$
$$\log I.H.P. = 3.1189.$$

Hence

$$I.H.P. = 1{,}315.$$

To obtain this value of indicated horsepower on the chart, obtain 4,500 on the displacement base and move vertically until the speed curve of 10.5 is reached at A. At this intersection move parallel to displacement base to B intersecting the coefficient line of 240. Again move

* Copyright by T. Addison, 1912.



Marine Engine Chart

(Copyright 1912 by T. Addison)

vertically from B to the point C on horsepower scale, this reading approximately giving the value obtained by calculation, viz: 1,315 horsepower.

Hence it can be seen that this corner of the chart eliminates the above calculation and gives results accurate enough for ordinary or preliminary calculations.

This corner of the main chart can also be of value by noting the variation of any one of the factors in the above formula by varying the value of any other factor. For instance, keep the displacement of 4,500 constant, speed constant (10.5 knots) and vary the value of the Admiralty coefficient. In other words, vary the form of the vessel.

Again, this chart can also be used to verify the Admiralty coefficient after trial trip runs, knowing the speed, displacement and indicated horsepower.

For example, let us assume a ship of 5,500 tons displacement, driven at 11 knots, develops 1,800 indicated horsepower. What is the coefficient?

From chart this value is = 230.

By calculation this value is = 230.4.

The second value to be obtained is that of mean effective pressure referred to the low-pressure cylinder.

Using the well-known formula:

$$P_m = F.\,P. \left(\frac{1 + \log_e R}{R}\right) - P_b \qquad (2)$$

Where P_m = mean effective pressure referred to low-pressure cylinder,
P = absolute boiler pressure in pounds per square inch,
P_b = back pressure in pounds per square inch,
F = diagram factor,
and R = number of expansions,

we have to assume the last three named factors.

Let us assume

P = 195 pounds per square inch (absolute),
P_b = 1.5 pounds per square inch,
R = 13 expansions,
and F = 0.61.

Inserting these values in formula (2) we have

$$P_m = 0.61 \times 195 \left(\frac{1 + 2.5649}{13}\right) - 1.5,$$
$$= 33 - 1.5,$$
$$= 31.5 \text{ pounds per square inch.}$$

Therefore, the mean effective pressure referred to the low-pressure cylinder = 31.5 pounds.

To obtain this value from the chart, first obtain 13 on the number of expansion scale. Move horizontally until the curve of 180 pounds is reached at D, and then vertically intersecting the diagram factor line of 0.61 at E. Again move horizontally to the effective pressure scale, where 31.5 pounds is obtained.

Hence this part of the main chart eliminates the calculation of formula (2).

Having obtained the indicated horsepower and mean effective pressure referred to the low-pressure cylinder, we can now use the regular formula:

$$I.\,H.\,P. = \frac{P.S.A.}{33{,}000} \qquad (3)$$

Where $I.\,H.\,P.$ = indicated horsepower,
P = mean effective pressure in pounds per square inch,
A = area of cylinder (low pressure) in square inches,
and S = piston speed in feet per minute.

Assuming

S = 450 feet per minute,

we have area of low-pressure cylinder[v]

$$= \frac{33{,}000 \times 1{,}315}{450 \times 31.5}$$
$$= 3{,}060 \text{ square inches, or } 62\tfrac{1}{2} \text{ inches diameter}^{v}.$$

This value of 62½ inches for the diameter of the low-pressure cylinder is obtained from the chart in the following manner:

Project the original indicated horsepower value of 1,315 vertically to meet the mean effective-pressure value, projected horizontally, at point F. At this point following the diagonal lines to point G. Move vertically from G until the piston speed value of 450 is intersected, and then move horizontally to the left and the area of low-pressure cylinder can be observed. This value is transferred to diameters by means of the curve in the upper left-hand corner, and hence the value of 62.5 inches is obtained on the uppermost line of the chart.

Thus we have obtained the diameter of the low-pressure cylinder for the above assumed conditions and eliminated all calculations in so doing.

The following ratios of diameters of cylinders have been assumed and agree approximately with the practice of many well-known firms.

These are:

H. P. Area	:	I. P. Area	:	L. P. Area
1	:	2.74	:	7.4

Hence

$$\text{Diameter of high-pressure cylinder} = \frac{3{,}060}{7.4} = 23 \text{ inches}$$

$$\text{Diameter of intermediate-pressure} = \frac{3{,}060}{2.7} = 38 \text{ inches}$$

Diameter of low-pressure cylinder = 62½ inches.

These values can be obtained on the chart in the lower left-hand corner in the following manner:

From the diameter of low-pressure cylinder = 62½ move verically to lines marked H. P. and M. P.Cylinder diameters and these values can be read off scale at side.

The stroke of the engine is obtained in like manner, being equal in this case to 45 inches.

Hence we have obtained the principal dimensions of a set of triple-expansion engines for a ship of 4,500 tons displacement of coefficient equal to 240 and driven at a speed of 10.5 knots, viz: 23-inch, 38-inch and 62½-inch diameters by 45-inch stroke.

There remains one calculation to make, which is to check the number of revolutions per minute of engines due to assuming piston speed equal to 450 feet per minute.

Revolutions per minute:

$$= \frac{\text{Speed in feet per minute}}{\text{Stroke in feet} \times 2} = \frac{450}{45 \times 2} \times \frac{12}{1} = 60,$$

which is a mean value for this size of engine.

From the chart we also observe the value of crankshaft diameter equal to 12⅜ inches.

To check this diameter to see if it is satisfactory let us use Lloyds rule and also the Board of Trade rule for crankshaft diameter.

Lloyds Rule:

$$\text{Diameter}^{v} \text{ in inches} = (0.038\ H.\,P. + 0.009\ I.\,P. + 0.002\ L.\,P. + 0.016\ S)\sqrt[3]{P}$$

Where $H.\,P.$ = diameter[v] of high-pressure cylinder in inches = 23 inches,
$I.\,P.$ = diameter[v] of intermediate-pressure cylinder in inches = 38 inches,

$L.\ P.$ = diameter^{v} of low-pressure cylinder in inches = 62½ inches,
S = stroke in inches = 45 inches,
and P = absolute boiler pressure in pounds per square inch = 195.

Hence diameter of crankshaft = 11.95 inches. Adding ⅜ inch for wear, etc., we have 12⅜-inch diameter^{v}.

Board of Trade Rule:

$$\text{Diameter in inches} = \sqrt[3]{\frac{\frac{1}{2} S P_a L^2}{1110\left(2+\frac{L^2}{H^2}\right)}}$$

Where H = diameter of high-pressure cylinder in inches = 23,
L = diameter of low-pressure cylinder in inches = 62½,
S = stroke in inches = 45,
and P_a = absolute boiler pressure in pounds per square inch = 1.95.

Hence;

$$\text{Diameter} = \sqrt[3]{\frac{\frac{1}{2}\times 45\times 62\frac{1}{2}^2\times 195}{1110\left(2+\frac{62\frac{1}{2}^2}{23\frac{1}{2}}\right)}} = \sqrt[3]{\frac{87890.6\times 195}{10411.}}$$

$= \sqrt[3]{1646}.$
$= 11.81 + \frac{3}{8}$ inch.
$= 12\frac{1}{4}$ inches.

[NOTE.—Blue Prints of this chart may be obtained upon application to writer.]

Compact Propelling Machinery Arrangements for Medium Size-Cargo Boats

Figs. 1 and 2 show the general arrangement of two types of steam-driven propelling machinery with Talbot oil-burning boilers for cargo ships of 44 and 56 feet beam respectively. Fig. 1 shows a twin-screw arrangement with ordinary triple expansion engines with cylinders 16 inches, 32 inches and 44 inches diameter by 28 inches stroke, designed to develop 1,000 horsepower each at 100 revolutions per minute, using steam at 185 pounds gage pressure. Fig. 2 shows a twin-screw arrangement with two 350-horsepower Talbot oil-burning boilers and uniflow engines.

With the arrangement shown in Fig. 1 when operated with superheated steam at 650 degrees Fahrenheit at the throttles, the steam consumption, as shown by numerous instances on record, is claimed to be slightly less than 12.5 pounds per horsepower hour.

The Talbot boilers shown are duplicates of the largest of this type which the Talbot Boiler & Engine Corporation, New York, has produced up to date. These boilers have proved to have a capacity of evaporation on test of 15,000 pounds of water per hour under ½-inch draft pressure. They have also proved their capacity in service, in one instance a single unit replacing a Scotch boiler of approximately five times its weight and over twice its heating surface operating under .4-inch draft pressure.

Each boiler has a width of 5½ feet, a length of 9 feet and a height of 10 feet 10 inches. The steaming weight of each boiler is 12 tons and the heating surface 1,350 square feet. An equivalent evaporation of 16.5 pounds of water per pound of heavy fuel oil is guaranteed by the manufacturers. The fuel consumption per horsepower for the main engines alone will thus be slightly less than 1 pound per indicated horsepower.

The thick bank of tubes comprising the upper heating surface, containing low temperature water, in these boilers permits a large increase of draft pressure and steam production without great loss of heat. The temperature at the uptakes has never been found high enough to require the usual inner casing of the stack or to burn the paint from a single sheet metal stack when the fuel is well atomized at the burners.

In any vessel having a beam of about 40 feet, the entire

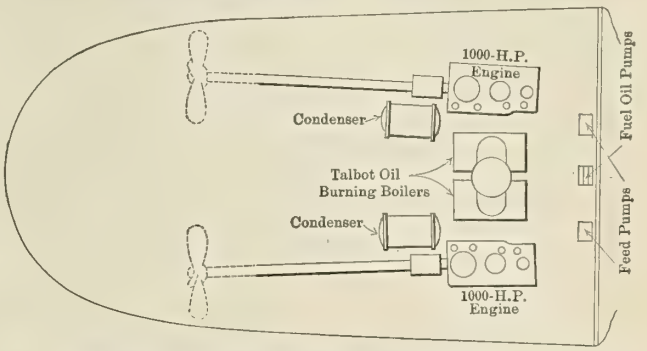


Fig. 1.—Talbot Oil-Burning Steam Plant of 2,000 Horsepower for 3,600-Ton Cargo Boat. Vessel is 288 Feet Long, 44 Feet Draft and 27 Feet Depth

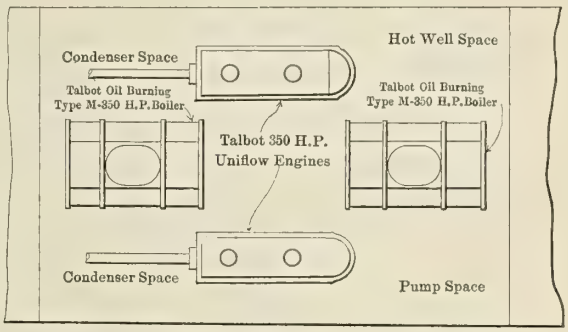


Fig. 2.—Talbot Oil-Burning Boiler and Uniflow Engines in Cargo Boat 110 Feet Long. Horsepower of Plant, 700

machinery space can be arranged as shown in Fig. 1, with the boilers in the fore-and-aft space required for the engines. In addition, the weight saved makes an increase of cargo space, while further gains in economy are made by the use of a low grade of fuel oil costing less but having more weight per gallon than is commonly used in oil-burning boilers. Further gains are also made as regards the use of cylinder oil, boiler compounds, gaskets and delays for cleaning boilers. Tube renewals are said to be so infrequent that the manufacturers supply new parts of the entire heating surface in exchange for worn-out or defective parts for a period of three years.

SUB-COMMITTEES OF COUNCIL OF NATIONAL DEFENSE.—The following new sub-committees of the Council of National Defense with their personnel were announced on May 9. The steel sub-committee consists of Judge E. H. Gary, James A. Farrell, Charles M. Schwab, James A. Burden, E. A. C. Clarke, president Lackawanna Steel Company; Alva C. Dinkey, of the Midvale Company, and W. L. King and John A. Topping, of the Republic Steel Company. A. C. Bedford, president of the Standard Oil Company, heads the sub-committee on oil. Chairmen of other committees are Horatio S. Rubens, director of the U. S. Industrial Alcohol Company, alcohol; Arthur V. Davis, aluminum; Charles F. Brooker, brass; W. H. Childs, coal tar by-products; R. H. Downmen, lumber; Clinton H. Crane, lead; L. W. Kingsley, mica; Ambrose Monell, nickel; H. Stuart Hotchkiss, rubber; Henry Whinton, sulphur, and Jacob F. Brown, wool.

Why Is a Ship Draftsman?

Rush Orders, Overtime Work and the Natural Result—The Chief's "Sure Cure"

THE *Mariposa,* a trading schooner, that was having some oil engines installed, came into the yard to have the tail shafts and stern bearings fitted. At noontime she was high and dry on dock, and when Casey went out into the yard after lunch he climbed aboard and got acquainted with the captain, who invited him into the cabin and treated him to a little of his private stock. Our town is a dry town—bone dry—and such a treat as this is a treat indeed. The whistle blew, and as Casey climbed over the side and started up the dock the captain laughingly called out and asked him to come again earlier and have lunch on the *Mariposa,* also to bring a couple of his friends. Casey thanked him and said that he would be on hand early the next day, and hurried toward the office.

Casey is clever—smooth. His father is a policeman. He can do less work and appear busier than any other man in the office. His board is always piled high with reference plans and his earnest, obliging manner is misleading. He stands well with the stenographers down stairs and gets the office gossip first. He sings and plays the piano. His tracings are beautiful and his printing is just like type, but the chief will not trust him to order material or check drawings. The chief is wise.

Lunch on the "Mariposa"

The next day a little before noon Casey passed the word to Charley Adams and Mike Shanon and they disappeared via the wash-room about ten minutes to twelve. The fat captain was glad to see them and led the way into his little cabin. The table was elaborately set with a red and white cover and blue and white china. There were several large trays full of beautiful and strange-looking tropical fruit. José, whose large mustache, black hair and dark skin showed him to be a Mexican, was cook and steward. When the captain entered he was leaning thoughtfully against the galley door with an extinguished cigarette apparently glued to his lower lip. After a cocktail, everybody sat down to the table and José glided in with numerous suspicious-looking peppery dishes. Casey was wise enough to praise extravagantly each dish, at which José smiled in a satisfied and knowing way. Why shouldn't he?—he knew what each one contained.

Chili warms the stomach and stimulates the appetite and they all ate everything that José brought in. When the captain had got a comfortable tension on his own round stomach and had swallowed a small cup of black coffee, he offered the boys some Mexican cigarettes—odd-looking things with black tobacco rolled up in dark licorice paper. "Mr. Casey," he asked, "have you or your friends ever seen fruit such as I have here on the table?"

No, they had not. "Where did it come from?" they inquired.

"Such perfect and rare fruit can come from but one place in the world—'La Isla de Las Mil y Una Doncellas' (The Island of the Thousand and One Virgins)—a veritable paradise off the west coast of Mexico," replied the captain. "You never heard of it before? Huh! Do you remember hearing some time ago of the discovery of an Adamless Eden? No! Say, you fellows are so wrapped up in this miserable shipyard of yours that you never hear or see anything but turbines, rivets, plates, and the like. Honest! you have never heard of the Adamless Eden? José, they never heard of La Isla de Las Mil y Una Doncellas!"

José shrugged his shoulders and sighed in a resigned sort of way.

The Captain Spins a Yarn

"Well, about ten years ago," continued the captain, "my uncle, who then captained the *Mariposa,* landed on this island for fresh water. The island is out of the line of travel and was practically unknown. When Uncle John cast anchor and sent a boat ashore, the people, all women, ran down to the beach and carried off the astonished and unresisting boat's crew. Uncle John followed in a second and armed boat. He was met by the queen and her following, all women, and escorted in state to the village, a short distance inland.

"Uncle John spoke a little Spanish and he finally pieced out that quite a few years ago the island had been invaded by natives who came from the mainland in canoes during the time of good weather. After a protracted battle, in which the defenders lost, the victors exterminated the male population and ordered the women to prepare a feast before being taken as slaves to the mainland. This the women did, but the queen's mother, then queen, quietly put some dope in the soup, and when the men were snoring in a stupid slumber on the beach the women fell upon them and revengefully killed every last one of them. The next day a storm destroyed the canoes and the island became an Adamless Eden and remained so until the *Mariposa* and Captain John happened along.

"The queen wanted Uncle John to stick around and be king. Now, Uncle John had a garden gate understanding with a girl in Boston to the effect that after this trip he would settle down and anchor in Boston. This understanding precluded any such arrangement as the queen suggested, but he knew that he could not sail the ship back to the States alone (the crew had promptly scattered and to all appearances each one of them was very much at home), so he decided that discretion was the better part of valor and explained to the queen as well as he could in a language that he had previously used only in a restricted business way, that he would agree to filling out an unexpired term and be king—pro tem., as it were. At the end of that time it would be his duty to return to the States.

"The queen was satisfied and Uncle John entered upon a reign that was decidedly novel. Watching his chance and using the same doped soup, he finally managed to get enough of the crew on board to man the ship and get away to the States, where a close corporation was formed to colonize and repopulate the island. Of course I returned with Uncle John, and have been there ever since, returning to the States once a year only to trade pearls for a few things that some of us on the island believe we must have.

"La Isla de Las Mil y Una Doncellas is my home and always will be. It is a wonderful place. Imagine, if you can, an island in the tropics where Adams are scarce and graceful, deer-eyed, olive-skinned Eves vie with one another to cultivate your favor by bringing luscious fruit, oysters, etc., to you while you bask in a glorious sun on a silvery beach backed by gently-waving cocoanut palms

and bathed by a beautiful blue ocean that breaks in a snowy foam at your feet. No work—no exertion, in fact, but that which is prompted by desire. Willing women gather enough of Nature's growth—farming operations such as you are familiar with are unknown on this island. There are great flocks of songbirds of gorgeous plumage. Deer, ducks and fish are plentiful. The largest and best oysters I have ever seen are found in abundance on the lower end of the island, and it is from the few of these that are gathered to eat that I annually get enough pearls to pay the expenses of the *Mariposa* and buy what is needed from the outside world. Unlike other places in the tropics, the heat here is not oppressive. Like Ireland there are no reptiles on the island. There are no mosquitoes on La Isla de Las Mil y Una Doncellas. A deep, beautiful blue lake gives us a bountiful supply of cold, sweet water. It is fed by a creek that drops into the lake over a waterfall that will some day furnish enough power for electric light and refrigeration for the whole island. A paradise, gentlemen, that may, if such a thing is possible, lack only a few more vigorous Adams like yourselves."

The boys looked at one another and José gazed pensively out of the galley door. Then the whistle blew. The captain looked disgusted. The boys got up, and after heartily thanking him, started back to the office. The captain detained Casey a minute and slipped some real estate circulars into his hand and asked him to drop around again later in the day.

Day Dreams Disorganize the Draftsmen

That afternoon was a hard one for Charley Adams. It was uncomfortable for him to reach to the far side of the board. He could not concentrate on his work. He saw lovely Doncellas carrying luscious fruit and passing in and out of the plate schedules and the frame spaces in the shell expansion.

Mike Shanon was away off also. He imagined that he sat on the captain's beach watching a restless ocean fling foam up to his feet while graceful maidens brought him large and wonderfully colored oysters, from which he selected a few of the largest and finest pearls.

Casey read and re-read the captain's literature, which even more elaborately described this marvelous Isla de Las Mil y Una Doncellas.

The chief had been instructed to rush to the limit plans for our last order for six freighters because deliveries on steel were going up six months at a jump. We had worked overtime every night for more than a week and everybody was pretty well slowed up. The idea of overtime at time and a half had been welcomed as a golden opportunity to get rich quick, but working all day and part of the night left no time to spend money. This was at last a case of all coming in and nothing going out. Mortgages would be taken off homes, autos bought and yachts fitted out. At the outset all was lovely.

Smith's young wife, with the extra money that Smith was making, was going to quit boarding and have a home of her own. After a week she complained that she hardly saw Smith any more. He came home all in and dumb except to kick about his lunch, and one night after she had commented on the poor way in which the Browns were building their bungalow and finally asked him if he did not agree with her, she found that he was sound asleep. He had never done this before, she said, and it was not a nice thing to do after she had been home alone all day and the greater part of the night. Life would not be worth living if this had to keep up.

That night work was out of the question for Adams and Shanon. The glow of José's warming dishes was gone and the reaction could not be easily met by tired eyes and a fatigued brain. A liver unaccustomed to chili holds back—goes slow, and the effect is one of depression. Gee! but ten o'clock was a long way off; it was getting cold, too. Mike looked around. Casey and Adams were down near the vault looking at a map. The chief had gone home, and a few minutes after he left Mac was called on the 'phone. He had to hurry home also. Some of us think the chief called him up and gave him an "out." Mike went over to the vault and was soon interested in the maps and pamphlets showing the wonders of the Isla de Las Mil y Una Doncellas. It was not long before everybody had gathered around and Casey was repeating parts of the captain's really marvelous and enticing description.

The "Grouch" Develops

Casey said that he was sick and disgusted with his job. A draftsman never amounted to anything nowadays. Ten or fifteen years over a board, and a man was either crazy or baldheaded—a fit subject for the nut factory. Old man Higgins, who was standing back a ways, slyly felt his head, and, finding a smooth bare spot on top, was reassured of his sanity. A draftsman is underpaid. Everybody agreed to this. Higgins spoke up and said that this could be remedied if everybody pulled for the A. S. M. D. Statistics show that in the shipbuilding business, on the average, machinists are paid the least, and draftsmen come next. All the other crafts are better paid. It used to be that a draftsman was part of the firm, but now, instead of designing and planning, he manufactures drawings. He is a skilled laborer who no longer is taken care of by the firm and who has no labor union. Some day the A. S. M. D., Higgins said, will stand for ten dollars a day and get it. Draftsmen are hard to organize. The prompt failure of the P. B. O. D. society (Poor Bloody Old Draftsmen) that went broke paying for its first banquet is a sad reminder of the first attempt at organization.

Drawing is not healthful. Hanging on the edge of a board all day displaces the stomach and organs from their natural position, irritates the breast bone, which causes coughing, and certainly knocks a man's eyes.

At this point the janitor came in and complainingly asked when we were going to be through with this overtime. He said that he and Pete, the watchman, were getting mighty sick of it all. He could not get his work finished until an unearthly hour at night and Peter could not get in his usual evening nap because there was so much noise. Somebody told him to tell his troubles to a policeman. He joined the circle and was soon very much interested in the pamphlets of the wonderful island.

A bat, that had been more or less disturbed for a week by the unusual light at night, came out of a ventilator and started looping the loop around the office. We all grabbed tee squares and gave chase, until Casey finally hit it and knocked it squeaking into a corner. It was put on a piece of paper and a lecture on bats followed. Somebody discovered that the bat was inhabited and it was thrown out the window, when the chief appeared on the scene. He had forgotten his other glasses, he said. After fussing around for a while, he went out and work stopped again.

Old man Higgins had constructed a perpetual motion machine and he had it running on his board. It had a small paper tube about ½ inch in diameter and about 5 inches long, supported on a toothpick axle in a couple of cardboard standards. Very slowly the paper tube seesawed on the toothpick axle in a sort of uncanny way. Some few of us who had seen this before knew that an ambitious fly, who persisted in walking up hill in the tube, was tipping it first one way and then the other. Tek

thought it was done by wireless. Instinct was the motive power.

"Say, boys, let us get up a colony and go down to that what-you-may call it island," said Mike Shanon. "That captain is right. A draftsman is stuck in a quiet upper corner of an office in a shipyard which is always out of town. He never knows anything that is going on except what he reads in the newspaper. I would like to go down on that island and put in a power plant on the creek that the captain was telling us about, and I'll bet I would have a good thing of it. Just think of those oysters and that beach and those—those thousand and one girls! Say, Casey, why the one? Ain't a thousand enough?"

"Easy Street" Looms Up in the Offing

"Well, you see," replied Casey, "if he said just a thousand there might be more or less; say seven hundred and fifty. But when you say a thousand and one, then there is no question. Just like two inches plus one thousandth—absolutely definite!"

"I see," said Mike.

"And besides, Mike," said Casey, "that one is different from all the other thousand."

"Me for the island," said Mike.

"You do not have to go down to an island to make money," said Higgins. "I have a scheme that, when a few minor details are perfected, will make me barrels of money."

"What is that, Dad?"

"Well, you see, out my way a groceryman is having all kinds of trouble keeping the dogs away from his place. He has a sign up, 'No Dogs Allowed in This Store.' In they go, just the same; don't see the sign, I guess. They say a dog's eyes are not very good, anyway. Only a few dogs can read or write well, so you can't blame the dogs. They have business in the store and, of course, in they will go if they can get in. Now, my scheme is to get up a sign that will appeal to a dog—something that he can understand readily. Dogs mean to do the right thing, I think. An advertising expert and I are working this up, and as soon as we get the minor details worked out we will put it on the market."

"What are these minor details, Dad?"

"Oh, the color effect, arrangement of the characters, etc., to give pulling or drawing power, as the expert says."

"You better try the sign on a vacant lot first, Dad, because it may have so much drawing power when you two get through with it that it will draw all the dogs in the country," said Mike

Ten o'clock had come and everybody piled out, glad to get out and hating to come back the next day.

Mac and the Chief Hold a Consultation

The next day Mac and the chief got together and decided something had to be done. The whole office had gone stale, just like a college boat crew that the chief remembered. They had been trained to the minute and the date of the race had been postponed two weeks because of the college president's death. In the case of the office, too much work, irregular eating at Dan's chop house, and La Isla de Las Mil y Una Doncellas was the cause.

Mac had been watching Higgins. It was two days yet to full moon, his piping plan was not finished and he was getting the look on his face that he had when he started to look for the blue elephants in back of the vault. If he fell down on this plan a new one would have to be made, because nobody at this stage could possibly unravel it.

The chief had met Roberts' mother on the street and she had asked him not to work Roberts too hard. She said that he was just working to keep up with the rest of us, hated to quit and would wear himself down and be sick. He is a hunchback, whose patience and good humor are out of all proportion to his physical disadvantages. Mac says he is the gamest man in the office.

The only thing Mac could think of was to lay off for a day or two on the night work. "What did they do with that boat's crew, chief?" he asked.

"Broke training by riotous living for a day and a night and started all over again," replied the chief.

"Let us do that here."

"How?"

"Give a banquet on the *Mariposa*. That son of a gun of a captain has probably had something to do with all this by his alluring lies and real estate schemes in regard to that wild island he was telling us about a couple of years ago when we helped him out of that smuggling trouble—the time he had his fresh water tanks full up with ammunition, etc., for that rascal Villa. 'Old Man of the Sea' was looking at his boat yesterday, when the Mexican cook on board, unfamiliar with dock rules, dumped a bucket of slop into the scupper, which squarely caught 'Old Man of the Sea,' who happened to be directly under it. There was some blue smoke around for a while, and the captain has not yet squared himself. They say that 'Old Man of the Sea' looked comical picking Mexican beans out of his hair."

The chief and Mac went down on the *Mariposa,* and after an argument and some forceful persuasion arranged to have a dinner for the drawing office force on the *Mariposa.* The chief arranged the menu with José, who quietly told the chief that many times the fat captain got muy triste (very sad—bilious) and he had to change the cooking to overcome this. The chief wanted to know if he could do this at the dinner in the evening. "Sure," promised José. "Go ahead," ordered the chief. "If it works you get five dollars—gold. Do you understand?" "Si, señor," said José.

José Administers the "Sure Cure"

Instead of to Dan's, everybody went on board the *Mariposa.* Some feast! "Old Man of the Sea" made a speech on the riveting of ships, and because he had been so unlucky and had provided a box of cigars, we all applauded. For dessert we had what José called dulce, a sort of a sweet apple sauce. Everybody enjoyed it, and "Old Man of the Sea" asked for a second helping. José handed it to him with a peculiar smile on his face. His skin was so dark that color could not have been noticed.

We all went home early. The next day everybody seemed cheerful, ambitious and full of the old-time spirit. Higgins finished up his plan. Numerous stamps were put on tracings, etc. Old Mac and the chief felt better, too. Mac told the chief that José was some cook. The chief said, "I think so." He seemed to get an idea, got up and hurriedly went down to the dock, which was just being lowered. He just had time to get aboard and hunt up José. "Here is your five spot, José; it worked fine. I am very pleased. Tell me, how did you work it?"

"I put licorice powder in dulce. I make him much strong. Your ol' man friend take twice. Ha! ha!" laughed José.

The chief hurried off and watched the *Mariposa* finally float away in charge of a couple of tugs. All that remained was a little oil from the anti-fouling paint and a

few chips of wood. The *Mariposa* had gone, and with her the disturbing captain, who was nothing more than a lying real estater.

That night everybody worked as usual. Old Mac and the chief stayed on the job, and there was no evidence of discontent. The chief called Mac over in a corner, and after some convulsed laughter, Mac was heard to say that the company would have to put in an order for a barrel of licorice powder and deal it out to "Greasy" Dan once or twice a week when necessary. "And 'Old Man of the Sea' got a double shot! No wonder he did not show up to-day," said the chief. "That José always had a deep look to me. You have to watch a Mexican. Licorice Powder—A Sure Cure for the Bilious Blues!"

State Nautical Schoolships

Training Officers to Man American Merchant Ships—Instruction in Navigation and Engineering

"NEVER before in the history of our country, not in the stirring times of the Napoleonic wars, not in the era of the sturdy packet ships or of the superb clipper ships, have the prospects of a sea life for the lads of our race been so advantageous and compelling as they are to-day." The foregoing statement prefaced a stirring address on "New Opportunities for Young Officers in the American Merchant Marine," delivered on February 14, 1917, by Winthrop L. Marvin, of Boston, before the Massachusetts Nautical School on board the *Ranger*.

In concluding his address, Mr. Marvin pointed out that for every sea-going American steamship of the year before this present war there will soon be two or three American ships requiring a master, a chief engineer and a full complement of watch officers, and there will steadily be other ships coming forward. "There are now building in our shipyards," he continued, "many steamers which cannot be completed before the end of 1918, and there are contracts which cannot be filled until long afterward. The destruction of allied and neutral tonnage by submarines will exceed this year by a wide margin of many hundred thousand tons the entire new shipping that can be built in America and elsewhere. Prosperity in ocean transportation and profitable employment for American ships will not cease with the war, but will continue after the war is ended. This whole nation of ours, and particularly the agricultural people of the South and West, have learned from the lessons of the war as never before the necessity for a great merchant shipping built and owned in the United States, and operated primarily in American interests."

The promising outlook, and, in fact, the urgent need for a great number of officers to man American merchant ships, should be a sufficient inducement to lead a great many young men to enrolment in the State nautical schools and other institutions where navigation, seamanship and marine engineering are taught.

It is humiliating to realize that in the past only two states, Massachusetts and New York, have maintained nautical schools for the instruction of young officers. Now, however, California and Washington have provided

Fig. 1.—New York State Nautical Schoolship *Newport* Weathering a Storm at Sea

STATE NAUTICAL SCHOOLSHIPS

On Board New York Schoolship Newport

Fig. 2.—During the First Year the Cadets are Required to Do Deck Duty in Actual Handling of the Ship

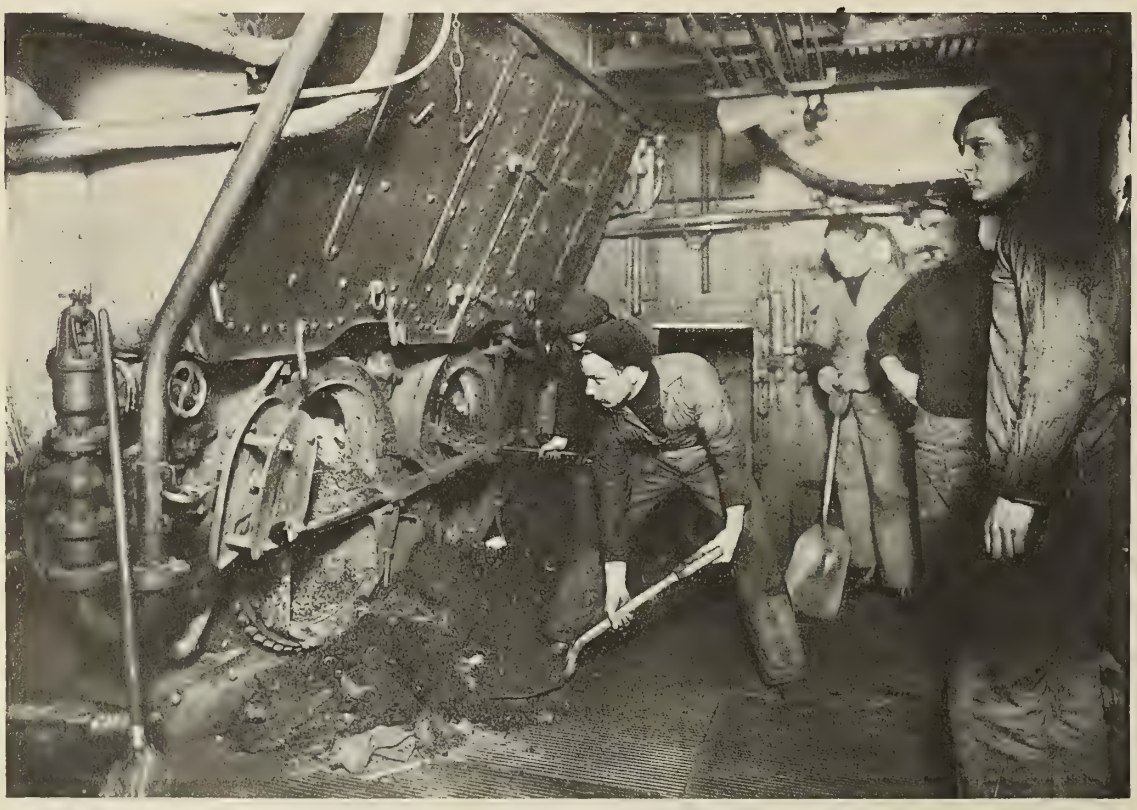


Fig. 3.—Cadets Specializing in Engineering Get Actual Experience in Firing and Handling the Machinery

Fig. 4.—Officers and Instructors on S. S. *Newport*

Fig. 7.—Knots and Splicing

for the establishment of schoolships, and it is hoped that all maritime States in the country will soon follow suit.

The New York State training ship is the *Newport*. This vessel is now fitting out at the New York Navy Yard as a patrol boat. For many years the home of the New York Nautical School was the *St. Mary*, which was maintained by the city of New York and under the direction of its Board of Education. More recently the *Newport* has been provided by the Navy Department, and since 1913 the schoolship has been under the direct jurisdiction of the State. Over 2,000 American boys have taken the two-year course on board the New York schoolship and have gone out to serve in the naval auxiliary or lighthouse department, or to command coastwise and ocean-going vessels. Such is the demand for graduates from this school that for the last two years 99 percent of the graduating classes were under pay and at sea two weeks after the close of the school year.

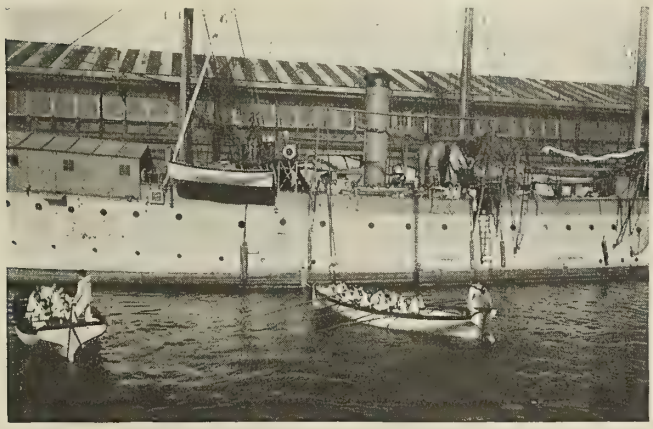


Fig. 5.—Boat Drill

In peace times, during the summer months, the students are taken on a long cruise on board the *Newport*, but during the winter the boat lies off the recreation pier at the foot of East Twenty-fourth street, New York. Much of the class work is done in the rooms on the pier. In addition there are many hours of practical work aboard the *Newport*, where the students are trained in every detail from shoveling coal to using the sextant. The course is a thorough one in the essentials of seamanship, navigation and marine engineering.

The cadets and instructors live aboard the ship under navy discipline. During their first year all the boys are required to do deck duty in the actual handling of the ship. They can then decide whether in their second year they will specialize in navigation or engineering. The ship's petty officers are selected from the honor students and in every branch of the work the boys get actual experience, thoroughly fitting them for the duties of officers in the merchant marine service.

Fig. 6.—Mess

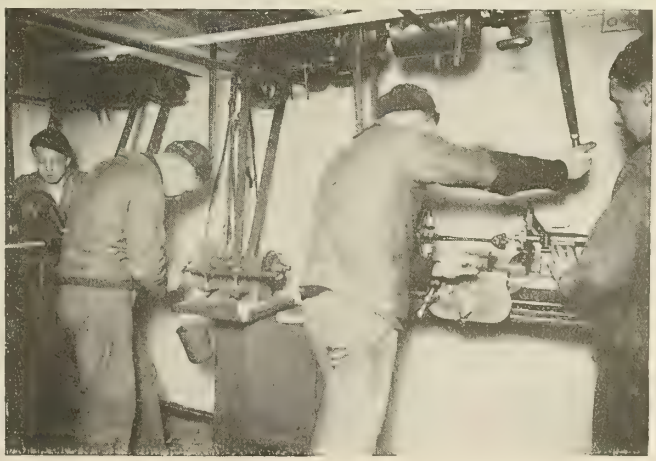


Fig. 8.—Machine Work

WOODEN SHIPBUILDING COMING INTO ITS OWN—OLD-TIME SHIPWRIGHTS AGAIN AT WORK

Old-Time Shipbuilders Hewing Out Ship Timbers With Their Adzes

Wooden Schooner in Frame, Fitting the Keelson

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Education

Engineers are insistently urged by many articles appearing in our trade journals to start early in their careers and obtain a broad and thorough grounding in the fundamental principles, in order that they may apply them to the practical solution of problems in engineering, such as furnace efficiency, thermodynamics, electricity, etc. More than this, they are expected to attain such ability and expediency as will be required to keep the boilers, engines and machinery of the ship in almost continuous service, with the highest possible score of economy.

Have you ever stopped to think of the unremitting, diligent study and labor these things require of an engineer, not for just a few years, but for as long as he may hope to qualify as a competent up-to-date engineer? This asks not just only the regular performance of ship's duties, but requires a large part of his personal time and money; money for membership to engineering societies, purchase of text books, instruments, and small tools, subscriptions to trade journals, personal time for attending lectures, visits to other ships' plants, and careful study of the books and periodicals devoted to the engineering field.

Many of our marine engineers have struggled up through all this arduous schooling and then have concluded that their qualifications and abilities are for naught. By this the writer means that their hands were tied by men in authority, such as corporation directors or others in the steamship establishment running the line of ships, who do not show any interest in the engineer department of a vessel, other than the thought that it is a necessary evil to run the ship. By tying of an engineer's hands the writer means that when the engineer makes a report on poor coal, or suggests the adoption of some new piece of machinery or instrument that he has carefully studied and knows that it will benefit the ship's efficiency, these things are either ignored or discouraged. Antiquated and inefficient machinery is nursed along, and when a raise is suggested for the fireman or others he is told that they are getting all they're worth, or some such excuse. It is, indeed, unfortunate that an engineer accepts any such a position, but circumstances are such at times that, in order to live, many do.

Therefore, it seems to the writer that a great deal of the educational work relative to the engineer department of a vessel is too one-sided, and that the superintendent or general manager of a line of ships should be urged to learn a bit more of the engineer department of his ships, or give the engineers more consideration of their problems.

It is my opinion that a manager or superintendent should possess an intelligent understanding of the requirements of the engineer's department of a vessel in sufficient degree to realize the necessity of proper equipment for economical operating; that he should be able to judge the ability of his engineers. Should he not be so qualified, then the engineer should be given full sway in all matters relating to the upkeep and running of his department.

I do not write this in hope that it will cause managers and superintendents to change their stand towards their operating engineers, but rather in hope that it will draw attention to the true cause as to why some ships' engineer departments are so dilapidated and wretched, in spite of a really intelligent engineer in charge. It is too easy to blame the ship's chief engineer for the poor conditions apparent, and without any thought of where the real blame lies.

When the high-up boss does not show any particular interest in the results of the engineer department of the vessel, it is foolish to expect enthusiasm from those serving under him.

ENGINEER.

"On Watch"

The article entitled "On Watch," by "Progressive Engineer," page 231 of the May, 1917, issue, is interesting. It is not strange to say that years ago, when I was a watch engineer at sea, the same thoughts occurred to me as referred to by your correspondent. Men are much the same all the world over, and at all times; so we frequently find others who think the same thoughts that we have thought, although at a different time and place. It is a sort of a "history repeating itself" idea, and probably will endure as long as man lasts. "Progressive Engineer" gives some very good suggestions, particularly to the younger set of engineers now in the making.

Now, just a few lines about engineers' catechisms to which the correspondent alludes in his letter. The question and answer, or catechetical, method of obtaining information should be thoroughly understood before it is adopted. Undoubtedly the catechism has its place in the technical literature of the day.

There are times when it comes in very "handy," as we say, and it frequently contains just the thing in particular that we want; but a catechism must be used intelligently, else it may perhaps prove a "delusion and a snare."

To the man who has a good knowledge of the fundamental principles of engineering and all that that involves, a good catechism on any engineering subject will prove of value to him, and very often be very convenient to refer to for some point in particular; but to the man who is seeking information of an elementary nature—a beginner—the catechism is not at all suitable or satisfying. Committing questions and answers to memory, as some learners attempt to do, is not any good. The catechism presupposes a good basic knowledge of elements and principles on the part of the reader, for then he will clearly see the application of the question and its answer as contained in the book.

The purpose of an examination of any kind is to discover how much or how little the candidate really knows of his subject, and it is not simply for the purpose of having a given number of questions answered, as so many persons seem to think. If a man knows his business he will be able to stand a fair examination, without committing to memory a set of questions and answers. If he does not know what he professes to know, then by the use of questions it will be discovered by the examiner.

Coaching and cramming for an examination, via the

catechism, may pull a man through, but later he himself "finds himself" and learns of his shortcomings and weaknesses. A man who studies only a catechism forms erroneous ideas of some of the things he reads about, and must at some time "unlearn" them, and begin all over. Why not, then, begin right? Study the fundamentals first, and use the catechism last. We still want the catechism, just as we need the Question and Answer Department in this journal, but we must first learn *how* to use them, and profit by them.

Scranton, Pa. CHARLES J. MASON.

Kinks

Fig. 1 shows a support that will be found quite handy for steadying the socket wrench when loosening a stubborn piston rod nut, or for rigidness when driving the nut on for keeps.

Fig. 2 shows a brass clip at A fastened to the guard rod, which serves as an indicator of the last reading of the oil

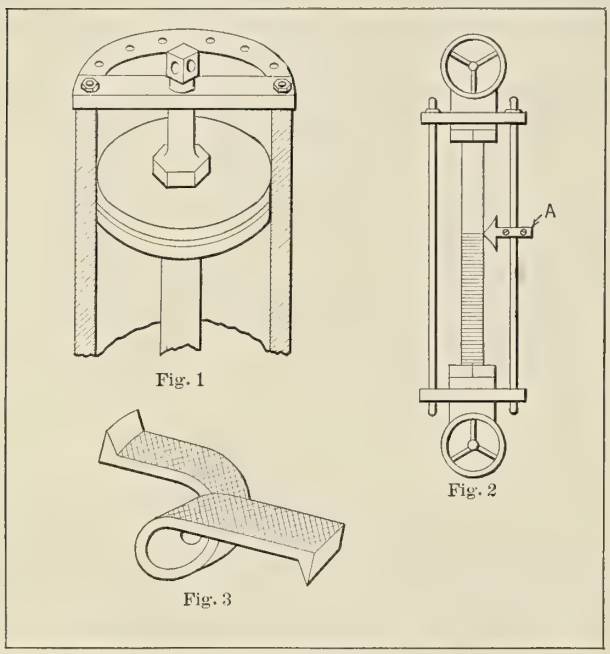


Fig. 1

Fig. 2

Fig. 3

Handy Kinks

level in fuel oil storage or settling tank. The rule for the operation of gage glass columns is to keep the valves closed, except when a reading is wanted. This indicator will always show the last reading.

Fig. 3 shows a tube scraper for 4-inch tubes made from an old file, which is secured to a 1-inch rod and revolved when being pushed through the tube.

HANDY.

Inspect the Feed Pipe

Recently the engineer of a transatlantic cargo vessel, fitted with Babcock & Wilcox boilers, related to me an experience that he had down below decks which came near costing the loss of his ship while coming home in ballast. Here is the story as told to me by the chief:

A submarine was sighted one day out of port, and immediately a call for full speed was given. All boilers were under steam at the time, four being light spread fires and the other four being worked. At the emergency signal things started to hum in the fire rooms. Everything was closed up for forced draft; the light spread fires were quickly built up and in ten minutes the old engines were pounding out 16 knots. Then trouble started. The water tender came tearing at breakneck speed into the engine room, yelling: "Speed up the feed pumps. We're losing the water in the forward boilers! The checks and stops are open wide, but we can't keep the water from dropping."

I jumped to the feed pumps, opened them up wide at the throttles, and then ran to the fire room just in time to see the water leaving the bottom of the glass in the two forward boilers. I immediately gave orders to check the fires of both of these and to handle the engines according to the steam.

In a few minutes the water was back to normal level in these two boilers; then we opened the dampers again, once more started working the fires, and speeded up the engines —then the same thing happened all over again.

The speed was again reduced, the two forward boilers were checked up and their water level regained, and when not forcing them we were able to keep the water at the normal level. I knew now that the trouble was somewhere in the feed piping of these two boilers. By forcing the other six and working these two as much as possible without undue risk, we managed to pull through, keeping up a zigzag course at top speed of 16 knots for eight hours.

Under normal steaming conditions we had never experienced any trouble feeding these boilers. As soon as we were safely out of reach of submarines on this side of the Atlantic I tackled the job of looking for the cause of the trouble. I had a feeling that there was something wrong with the feed checks or stops, that they, perhaps, would not open wide. But after inspecting these, they were found in good condition. I then opened up the drums, took out the internal feed line, and here we found the cause of our trouble.

The pipes were more than half plugged with grease, sediment, small pieces of rubber valves and grit. This foreign matter had gradually accumulated until it had so filled the pipe that the discharge area was reduced. The boilers, when forced, evaporated more water per second than the reduced feed line opening could supply.

This lesson, taught by experience, will never be forgotten. The story is worth handing on to other fellows. It shows the need of inspecting the internal feed pipes more often. C. H. W.

Prepare for the Future

Prepare for the future—begin to right now!
Make the most of yourself—that should be your vow.
Focus your will power on getting ahead;
Use good sense and foresight, have faith, and don't dread
To meet opposition—of that you are sure;
The position you wish is to others a lure.

Remember the impulse to get ahead spurs
On endeavors the best, self fits you, and blurs
That feeling of failure and thinking you'll quit;
It's your attitude mental that makes you quite fit.
Advance surely each year—have patience—don't fret;
In time the reward you have worked for you'll get.

To know you are mastering difficult things
Makes the struggle a pleasure, and strength to you brings.
To meet every obstacle right now prepare!
Don't ever give up! Go ahead! You'll get there!
There's a chance waits for you—have courage—start in
And fully prepare—then success you will win.

Concord, N. H. C. H. WILLEY.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

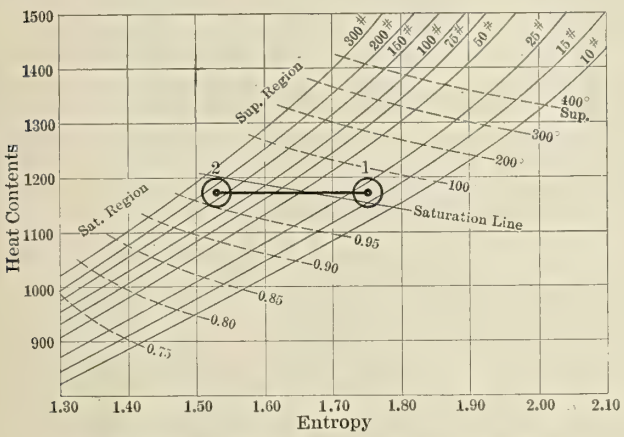
BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

How to Work Up Data from Peabody Throttling Calorimeter

Q. (884).—Will you please show me the easiest way to work up the following observations taken on a throttling calorimeter of the Peabody type: Steam line pressure, 165.3 pounds gage; chamber pressure, 5.3 pounds gage; chamber temperature, 253 degrees F.

A. (884).—The simplest way is to use the Heat Contents-Entropy Diagram, commonly called the Mollier Diagram. The absolute pressures assuming 14.7 pounds to be the atmospheric pressure, are 165.3 pounds + 14.7 pounds = 180 pounds in the line, and 5.3 pounds + 14.7 pounds = 20 pounds in the chamber. The temperature corresponding to 20 pounds is 228 degrees F., therefore the superheat in the chamber of the calorimeter is 253 degrees — 228 degrees = 25 degrees. With the *pressure* and *superheat* as arguments, enter the diagram and we land on a heat contents of 1,168. As the change has been at constant heat contents, follow this heat contents line over till we reach the line pressure of 180 pounds. The quality is then read directly as .978



Heat Contents—Entropy Diagram (Mollier Diagram)

NOTE.—Peabody's diagram used. See figure, find position No. 1, then go to position No. 2 and read quality directly.

Steam Consumption of Marine Pumps

Q. (893).—What is a good average value for the steam consumption of marine pumps and how is the power necessary determined in a design?

A. (893).—It is very large, as they usually take steam full stroke, thus having no expansion and an abnormal amount of cylinder condensation. It is common practice to allow 120 pounds of steam per brake horsepower per hour for boiler feed pumps running at a constant or nearly constant rate and to allow 200 to 300 pounds per brake horsepower per hour, if the unit is started and stopped frequently, the increase in the second case coming from the condensation in the steam line to the throttle.

To find the work of a pump, multiply the pounds of water fed by the head (feet) equivalent of the pressure against which it is to operate and increase by about 50 percent to allow for slippage, friction, etc.

NOTE.—One pound per square inch = 2.5 feet of water, approximately.

Efficiency of Steam Engine

Q. (891)—Why does the steam engine in actual operation not conform to the theoretical or ideal engine or one whose efficiency is 100 percent?

A. (891).—The question is important and its answer needs to be prefaced by a brief statement as to just what we mean by efficiency. Roughly, we may say that efficiency is the ratio of

$$\frac{\text{output}}{\text{input}}, \text{ or } \frac{\text{work done}}{\text{energy supplied}},$$

or for an engine which transforms heat into work, as a steam engine,

$$\frac{\text{the work done}}{\text{the heat energy supplied}}$$

Oftentimes we are not so much interested in this fundamental efficiency (called thermal efficiency) as in the percentage by which an actual unit approaches an ideal unit which transforms all the energy *available between its working limits* of temperature into work; this is variously called the efficiency of performance, cylinder efficiency and commercial efficiency. To illustrate: If a boiler supplies steam to an engine at 150 pounds pressure (absolute) and the engine discharges to a condenser at 28 inches vacuum, all that goes to the condenser is wasted as far as the engine is concerned. This is a large portion (72 percent) of the total heat energy which was brought into the engine at the throttle and exists even if the engine has transformed the difference between supply and exhaust entirely into work. This *waste* is decreased by lowering the exhaust temperature or increasing the admission temperature, consequently the percentage of the energy available in this range to the total heat energy (reckoned clear down to absolute zero) that was brought in with the steam, called the thermal efficiency, is increased.

For this case the thermal efficiency (Rankine cycle) is 28.2 percent and in general ranges from 15 percent to 30 percent.

If we are willing to neglect this conception and simply say that our definition of efficiency shall be the ratio of the work which the actual engine produces to the work which an engine *working between the same temperature limits* would produce if it transformed all of the heat energy available between those limits into work, then we have the second sort of efficiency mentioned above, or "commercial efficiency"; this in practice ranges from about 40 percent

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

to 75 percent, and the principal sources of loss are as follows:

Condensation of steam on cylinder walls.
Leakage and radiation.
Friction.

Reactions of Propeller Shafting at Strut Bearings

Q. (877).—In attempting to derive a design factor for the strut bearings of propeller shafting I have needed the reactions at these bearings. I believe these can be estimated by the methods applied to the solution of continuous girders, but have had difficulty in the solution, as the reactions so found do not sum up to the total loads. I enclose a sketch of a specific case, and should greatly appreciate it if you would determine the reactions at the bearings numbered 1, 2 and 3. I have considered the shaft cut off short at 10 feet forward of bearing number 3, which is not the case, but I know of no better assumption, and some one was necessary, which would shorten up the computation.

A. (877).—An exact solution of this problem could be obtained for any number of spans and any loading, by applying the "three moment equation" to each two consecutive spans and solving the system of simultaneous equations thus found. If we can reasonably approximate the moment at the third support, the shaft forward of it

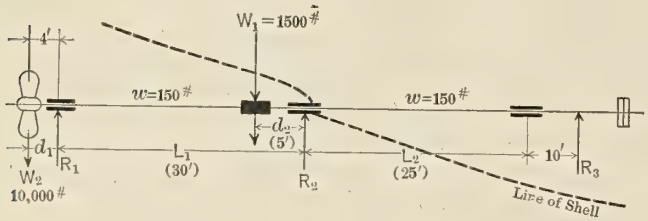


Fig. 1

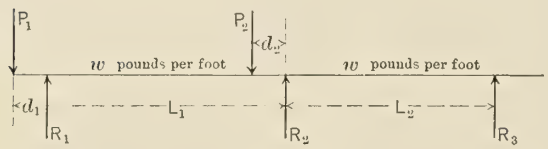


Fig. 2

may be neglected. We may then apply the three moment equation to the first two spans and solve for the moment at the second support, as all other quantities in the equation will be known. Then will thus result the moments at the first three supports, which in turn permit the finding of these reactions.

For uniform loading $\frac{-wL^2}{12}$ is a practical value for the moment at the third support of a beam of any number of spans greater than three, as may be seen by a comparison of the exact values calculated for beams of four, five, six and seven spans. The weight per foot of shaft is w, and L is the length of one span in feet.

Now considering the concentrated loads, we find from exact analysis that for the case of loads to the left of R_2, the moment at the third support will be practically one-sixteenth of the known moment at the first support. This will not be correct, if there are concentrated loads in the other spans, although if there are loads several spans to the right of the third support, this result will not be materially altered. The part of the uniform load to the left of the first support may be considered as part of the concentrated loading, and this has been done in the following solution, which accords with the preceding assumptions.

Let M_1, M_2, M_3 be the moments at the supports 1, 2, 3 respectively, and R_1, R_2, R_3 the corresponding reactions. Now

$$M_1 = -P_1d_1 - \frac{wd_1^2}{2}, \text{ and } M_3 = \frac{M_1}{16} - \frac{wL_2^2}{12},$$

according to the previous assumptions.

Applying the "three moment equation" to the spans L_1 and L_2, we have:

$$L_1M_1 + 2(L_1 + L_2)\ M_2 + L_2M_3 + 2L_1P_2d_2 - 3P_2d_2^2 + \frac{P_2}{L_1}\ d_2^3 + \frac{w}{4}\ (L_1^3 + L_2^3) = O.$$

In this case

$$M_1 = -\ 10000\ (4) - \frac{150\ (16)}{2} = -\ 41{,}200 \text{ foot pounds.}$$

$$M_3 = -\frac{41200}{16} - \frac{150\ (625)}{12} = -\ 10{,}400 \text{ foot pounds.}$$

Hence,

$$-41200\ (30) + 2\ (55)\ M_2 - 25\ (10400) + 2\ (30)\ (1500)\ (5) - 3\ (1500)\ (25) + \frac{1500\ (125)}{30} + \frac{150\ (27000) + (15625)}{4} = O.$$

And

$$M_2 = -\frac{446{,}200}{110} = -\ 4{,}050 \text{ foot pounds.}$$

Taking moments of the forces to the left of the second support, we have:

$$M_2 = -P_1\ (L_1 + d_1) + R_1L_1 - P_2d_2 - \frac{w\ (L_1 + d_1)^2}{2},$$

or

$$-4050 = -\ 10000\ (34) + 30\ R_1 - 1500\ (5) - \frac{150\ (1156)}{2},$$

whence,

$$R_1 = \frac{430{,}150}{30} = 14{,}340 \text{ pounds.}$$

In like manner, taking moments about the third support:

$$M_3 = -P_1\ (L_2 + L_1 + d_1) + R_1\ (L_2 + L_1) - P_2\ (L_2 + d_2) + R_2L_2 - \frac{w\ (L_2 + L_1 + d_1)^2}{2},$$

or

$$-10400 = -\ 10000\ (59) + 14340\ (55) - 1500\ (30) + R_2\ (25) - \frac{150\ (3481)}{2},$$

whence,

$$R_2 = \frac{97000}{25} = 3{,}880 \text{ pounds.}$$

Now R_3 will not be equal to the sum of the loads minus $(R_1 + R_2)$, since we have assumed the beam to continue indefinitely to the right of the third support, and by so doing have not assumed sufficient data to calculate it exactly, but with fair approximation it may be computed in that way, so that

$$R_3 = (21850 - 18220)\ 1.10 = 3{,}993 \text{ pounds.}$$

An exact analysis of a five-span beam, the first two spans being as shown above, and the remaining spans each 25 feet long and subject to the same uniform loading, gives the value of

$R_1 = 14{,}370$ pounds, and $R_2 = 3{,}870$ pounds, $R_3 = 4{,}080$ pounds.

It should be borne in mind that the flexibility of the ship's hull and the varying thrust of the crank can inject effects which may preponderate over the simple reactions computed as above.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The Navy Department has awarded contracts for twenty-four 1,000-ton mine sweepers to private shipbuilders who now have no Government work on hand. The contracts have been placed with the Standard Shipbuilding Company, New York; Staten Island Shipbuilding Company, New York; Harlan & Hollingsworth Corporation, Wilmington, Del.; Sun Shipbuilding Company, Chester, Pa.; Bethlehem Steel Company (Maryland plant), Sparrows Point, Md.; Chester Shipbuilding Company, Chester, Pa.; Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.; Pennsylvania Shipbuilding Company, Gloucester, N. J.; Todd Shipbuilding Corporation, New York, and Pusey & Jones, Wilmington, Del.

The Navy Department has also awarded contracts for twenty-four submarines to the Electric Boat Company, New London, Conn.; four submarines to the Lake Torpedo Boat Company, Bridgeport, Conn., and ten submarines to the navy yard, Portsmouth, N. H.

Contracts for four additional torpedo boat destroyers have also been placed with the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

At the recent Big Waterways Congress at St. Louis, Mo., a movement was set on foot for the rehabilitation of water transportation on the Mississippi and its tributaries. Two barge corporations are to be formed, one with a capital stock of $2,000,000, to operate lines of boats and barges from St. Louis northward to the twin cities, and the other, with a capital stock of $1,500,000, to operate a similar service between St. Louis and New Orleans.

A naval base near Houston, Tex., comprising a navy yard, docks, naval training station, arsenals and ordnance factories, is proposed.

Wood-Working Machinery for Shipbuilding

Recent sales of woodworking machinery, according to the *Iron Age*, while largely increased over what they were a few weeks ago, have been for the most part to builders of submarine chasers, not to builders of wooden cargo boats under the Government plan. There is no close gage of just how much equipment will be taken for the latter work, and the fact that the Federal Shipping Board has not definitely decided on the original proposition of 1,000 wooden boats leaves the entire matter in an indefinite state.

It is evident from their contact with dealers that a great many prospective builders lack first-hand knowledge of shipyard work to an extent similar to some munition makers at the start of the war.

Some large yards are contemplated. One inquiry for locomotive cranes calls for sixteen cranes, one for each way, and ten additional cranes for service work about the plant. A moderate-sized yard, consisting of, say, three ways, is estimated to require about $20,000 worth of wood-working machinery and also metal-working tools.

Some prospective shipbuilders entertain the delusion that they can secure equipment immediately, by merely stating that they intend to build wooden ships. Others expect to get a Government order which will compel machinery dealers to hand over tools. Many fail to realize that other industries are equally vital and that equipment cannot be had immediately in most cases.

Manufacturers of wood-working machinery have no large stocks ahead, partly on account of the difficulty, now long existing, of getting materials. The larger plants are booked for two or three months ahead. An average delivery on this equipment is from 60 to 90 days. Large machines, which are the most needed in wooden shipbuilding work, are the hardest to get and require the most time to manufacture.

$25,000,000 Being Spent in Canada for Steel and Wooden Ships

Steel and wooden shipbuilding will be among the most important of Canadian industries in the near future. According to reports the British and Canadian Governments have already placed contracts for ships and shipyards totaling $25,000,000.

Among the many new Canadian enterprises is a shipbuilding plant, with a capital of $1,000,000, which is being organized in St. Johns, N. B. The International Shipbuilding Corporation has also recently been incorporated, with a capital stock of $2,000,000, with head offices in Montreal.

The Canada Steamship Lines Company is reported to be considering establishing a plant at Hamilton, Ont. The Canadian Shipbuilding Company will build a plant at Bridgeburg, and the National Shipbuilding Company will operate a plant at Goderich, Ont.

The Welland Shipbuilding Company, Ltd., St. Catherine, Ont., has been incorporated, with a capital stock of $200,000, by Francis H. Keefer, Donald Munro and others.

Mayor Gray, of New Westminster, B. C., is among those interested in the project of building a shipyard for the construction of wooden vessels.

Contracts for Submarine Chasers

The United States Navy Department, Washington, D. C., has given contracts to build 203 submarine chasers as follows:

		Each
Barrett Shipbuilding Co., Mobile, Ala	4 at	$44,000.00
F. M. Blount, Pensacola, Fla	4 at	45,000.00
Burger Boat Co., Manitowoc, Wis	1 at	52,000.00
Chance Marine Construction Co., Annapolis, Md.	1 at	52,000.00
	2 at	49,000.00
Camden Anchor-Rockland Machine Co., Camden, Me	2 at	51,000.00
Charles A. Dean, Alexandria, Va	20 at	48,250.50
Dubuque Boat & Boiler Works, Dubuque, Ia.	2 at	52,000.00
The Elco Co., Bayonne, N. J	16 at	50,000.00
Eastern Shipyard Co., Greenpoint, N. Y	5 at	50,900.00
L. E. Fry & Co., Clayton, N. Y	2 at	43,795.00
	2 at	42,000.00
Great Lakes Boat Building Corporation, Milwaukee, Wis	2 at	52,000.00
Gibbs Gas Engine Co., Jacksonville, Fla	3 at	44,500.00
	2 at	43,000.00
Hodgdon Bros., East Boothbay, Me	1 at	37,500.00
	2 at	35,800.00
Hartman Greiling Co., Green Bay, Wis	2 at	40,266.75
C. Hildebrandt Drydock Co., Kingston, N. Y.	15 at	44,540.00
International Shipbuilding & Marine Engine Co., New York	1 at	48,000.00
	9 at	46,000.00
Robert Jacob, City Island, N. Y	5 at	52,000.00
Kyle & Prudy, City Island, N. Y	5 at	52,000.00
George Lawley & Son Co., Boston, Mass	20 at	52,000.00
Luders Marine Construction Co., Stamford, Conn.	5 at	52,000.00
Mathis Yacht Building Co., Camden, N. J	5 at	49,200.00
	6 at	43,892.00
	4 at	42,892.00
Alex. McDonald, Mariners' Harbor, L. I., N. Y	1 at	49,829.00
	3 at	49,329.00
The Newcomb Life Boat Co., Richmond, Va.	1 at	49,865.00
	4 at	48,565.00
The Matthews Co., Port Clinton, Ohio	10 at	52,000.00
New York Yacht & Engine Co., Morris Heights, N. Y	20 at	49,950.00
Rocky River Drydock Co., Rocky River, Ohio.	2 at	52,000.00
Smith & Williams Co., Salisbury, Md	2 at	52,000.00
Vineyard Shipbuilding Co., Milford, Del	2 at	42,300.00
	1 at	41,500.00
Howard E. Wheeler, Brooklyn, N. Y	9 at	47,085.00
Total (203)		$9,768,059.50

Shipyard Mechanics Urgently Needed at Philadelphia Navy Yard

The following list of mechanics and artisans urgently needed at the League Island Navy Yard, Philadelphia, gives an excellent line on wages now offered by the Government for certain classes of workers: Nine boatbuilders, at $3.04 to $4 a day; five riggers, at $2.88 to $3.76 a day; five riggers' helpers, at $2 to $2.48 a day; twelve shipfitters, at $4.24 a day; fourteen shipwrights, at $3.04 to $4 a day; fifteen drillers, at $3.04 a day; twenty coppersmiths, at $3.28 to $4.24 a day; twenty coppersmiths' helpers, at $2 to $2.48 a day; ten laborers, at $1.76 to $2.24 a day; twenty-one painters, at $2.80 to $3.60 a day; fifty painters' helpers, at $2 to $2.48 a day; boiler makers, at $3.28 to $4.24 a day, and boiler makers' helpers, at $2 to $2.48 a day.

Urgent Need of Ships for Coast Defense

The Navy Department has urged upon the consideration of the House Committee on Naval Affairs its urgent need for ships for the coast defense fleet, and has suggested legislation to enable the Department to commandeer those it requires at a reasonable price.

A number of the finest yachts in the country have been tendered to the Government by the owners for use during the war, either free or on a nominal lease, and numerous vessels of other types, including smaller boats, have been bought or leased; but a great many more are needed.

The owners of a number of the vessels that are sought by the navy are asking exorbitant prices for them. About 200 yacht owners have refused to sell their vessels to the Government at prices to be fixed by the Board of Appraisal, and several have refused to sell at any price.

The Navy Department has inspected approximately 600 privately-owned vessels. Of these approximately 500 have been found suitable. The owners of 192 have entered into agreement to turn their boats over upon notification and have been so notified.

Owners of most of the tugs and fishing boats suitable for this work absolutely refused to consider either lease or purchase; others asked outrageous prices. As an example, a fishing vessel was appraised for $30,000; the owner would not sell for less than $112,000. The $30,000 was more than the cost of the vessel.

Shipbuilding Contracts

The Superior Shipbuilding Company, Superior, Wis., a branch of the American Shipbuilding Company, Cleveland, Ohio, has received a contract to build 18 steel steamships. Ten of these will be 263 feet long, with a gross tonnage of 2,500, and the other eight are to be trawlers.

John M. Dullahan, Orange, Tex., and A. R. Daugherty, New York, are stated to have received contracts to build seven steel steamships at Orange. The Terry & Tench Construction Company, Grand Central Terminal, New York, is in charge of the construction.

It is reported that J. V. Paterson, formerly president of the Seattle Construction & Dry Dock Company, has received contracts to build six submarines for the Russian Government. It is reported that these submarines are to be built at Vancouver, B. C.

The Merrill-Stevens Company, Jacksonville, Fla., has received contracts to build four 5000-ton steel vessels and is taking steps to enlarge the plant to provide facilities for building them.

It is stated that the Ames Shipbuilding & Dry Dock Company, Seattle, Wash., has a contract to build fifteen steel steamships, ranging from 8,500 to 9,000 tons each.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., has received a contract to build two 3,500-ton steel vessels.

W. L. Henderson, president of the Henderson Iron Works, Mobile, Ala., is said to have closed contracts to build several vessels for the Government.

Salmen Bros., Slidell, La., are building a freight steamship for Norwegian owners.

McGuckens & Hyer, Tampa, Fla.; F. H. McConnell, Jacksonville, Fla., and W. T. Wells, Arcadia, Fla., are reported to have received contracts to build six wooden ships.

The National Shipbuilding Company, Puget Sound, Wash., has received a contract to build two 3,500-ton wooden freight ships.

Henry Piaggio, Gulfport, Miss., is building five 301-foot auxiliary schooners in his yards at Orange and Beaumont, Tex.

The Orange Maritime Corporation, Beaumont, Tex., has received a contract to build a 1,000-ton wooden schooner.

Ernest Jahncke, New Orleans, La., is said to have secured a contract to build six wooden ships.

E. James Tull, Pocomoke City, Md., has received a contract to build four barges for the Diamond Point Boat Line, Philadelphia, Pa.

J. F. Duthie & Company, Seattle, Wash., have received a contract from the Cunard Steamship Company, New York office, 24 State street, to build three 8,800-ton steel steamships.

It is reported that the Baltimore Dry Docks & Shipbuilding Company has received a contract from the Garland Steamship Company to build a 340 foot steel freight steamship.

The Hind-Rolph Coal & Navigation Company, San Francisco, Cal., will build three wooden steamships and a five-masted barkentine at its new yard near Eureka, Cal.

The National Shipbuilding Company, Seattle, Wash., recently organized, is reported to have received contracts to build two 3,500-ton wooden ships.

The Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal., is reported to have received contracts to build four more 7,000-ton steel freight ships.

The Western Shipbuilding Company, Tacoma, Wash., has received a contract to build an auxiliary schooner.

Shipyard News

The Potomac Shipbuilding Company, Orren G. Staples, Washington, D. C., president, has been organized and will build a yard at Quantico, Va. George C. Shepard, Baltimore, Md., is engineer and general manager.

According to reports a large steel shipbuilding plant is to be established in Baltimore, Md. Among those mentioned as active in organizing the project are Bernard N. Baker and E. M. Newton, both of Baltimore.

It is reported, on apparently good authority, that J. W. Thompson, a St. Louis contractor, has arranged for the establishment of a large shipbuilding plant at New Orleans, and it is stated that Mr. Thompson has received enough contracts from the Government to run the plant at full capacity for at least three years.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., will spend $2,000,000 in building a new plant. Day & Zimmerman, Philadelphia, Pa., have the plans in charge.

The Downey Shipbuilding Corporation, Wallace Downey, 120 Broadway, New York, president, has been incorporated, with a capital stock of $5,000,000. The new company is planning the erection of a shipbuilding plant for the construction of freighters at the steel works of Milliken Bros., Staten Island, N. Y.

The Pennsylvania Shipbuilding Company, Land Title building, Philadelphia, Pa., has increased its capital stock from $600,000 to $1,000,000, in order to provide for expansion.

The Lone Star Shipbuilding Company, established at Beaumont, Tex., has now completed its organization. McBride & Law, Beaumont, are back of this project.

Stone & Webster, Boston, Mass., are reported to have secured 25 acres of water front at Seattle, Wash., with the anticipation of building a large number of wooden ships for the Government.

The Elco Company, Bayonne, N. J., manufacturer of motor boats, is making extensive additions to its plant.

The New London Shipbuilding Corporation has been organized in the State of Delaware, with a capital stock of $10,000,000. Samuel B. Howard, 28 Nassau street, New York, is one of the directors. It is understood that this company will build a shipyard at Groton, Conn.

The Maryland Shipbuilding Company, Baltimore, Md., with a capital stock of $1,000,000, has been organized by J. E. Aldred, of the Consolidated Gas, Electric & Power Company, Baltimore, and associates. The president of the company is Charles E. F. Clarke, president of the Pennsylvania Water & Power Company, Baltimore.

The Charleston Shipbuilding Company, Charleston, S. C., has been organized, with a capital stock of several million dollars. It is understood that Whittelsey & Whittelsey, 17 Battery Place, New York, have charge of the laying out of the plant, etc.

Henry Lysholm, Woodbury, N. J., and associates have incorporated the New Jersey Shipbuilding Company. Haakon E. Norbom, Germantown, Philadelphia, is one of those interested.

Shops and Forward End of Shipways at Skinner & Eddy Yard, Seattle, Wash.

The Biloxi Shipyard & Box Factory, Biloxi, Miss., has been incorporated, and it is reported will build submarine chasers for the Government.

The Phœnix Shipbuilding Company, New Orleans, La., has been incorporated, with an authorized capital of $2,000,000. The incorporators' names have not been announced.

The Seaboard Transportation & Shipping Company has been organized at Galveston, Tex. Henry J. Schutte is general manager and T. J. Anderson naval architect. The company is planning to build a marine railway, dry dock and general shipbuilding plant.

The Murnan Shipbuilding Corporation has been organized at Mobile, Ala., with a capital stock of $3,000,000. The president is Solomon F. Glens, Philadelphia, Pa.; vice-president, H. C. Murnan, Mobile, Ala.

The Skinner & Eddy Corporation, Seattle, Wash., will install new machinery as a result of receiving a contract to build a 9,500-ton steel oil tanker.

The Everett Shipbuilding Company, Everett, Wash., has been organized, with a capital of $100,000, to build wooden ships.

George W. Bush, San Diego, Cal., has acquired a tract of land at the foot of Beardsley street, for the purpose of erecting a shipbuilding plant.

Wilson Bros. Shipbuilding Company, Astoria, Ore., has been incorporated to take over the plant of Wilson Bros. The new corporation is planning to build three new ways and to install a full line of shipbuilding machinery.

The Anderson Shipbuilding Company, Seattle, Wash., has consolidated with D. H. Gray & Company and R. F. Guerin, under the name of the Anderson Shipbuilding Corporation. J. L. Anderson is president; L. H. Gray, vice-president, and R. F. Guerin, secretary. It is reported that work on the first of many 3,000-ton wooden ships will be begun at once.

Fred L. Baker, president of the Baker Iron Works, 950 North Broadway, Los Angeles, Cal., and associates are organizing a company to construct and operate a large shipbuilding plant. It is planned to spend several million dollars on the project.

H. L. Gastman and Arthur Leclear, Eureka, Cal., are planning to build a shipyard on Humboldt Bay.

The Gray's Harbor Motor Ship Corporation has started work on its shipbuilding plant in Aberdeen, Wash.

The Marine Iron Works, Seattle, Wash., has purchased a site and will establish a wooden shipbuilding plant. Sufficient contracts are said to have been already received to keep the plant busy for two years. Peter O. Peterson is president; A. M. McLain, vice-president, and Frederick H. Batton, secretary and treasurer.

The Seattle Machine Works, Seattle, Wash., is planning the immediate erection of a manufacturing plant to turn out heavy oil engines to meet the demands of the wooden shipbuilding industry. It is stated that engines from 75 to 300 horsepower will be constructed.

The Cavotto Shipbuilding Company, Seattle, Wash., has been incorporated and is planning to start work on a shipyard at an early date.

John H. Kirby, Houston, Tex., president of the Kirby Lumber Company, is organizing a corporation to construct a shipyard at Beaumont, Tex.

The International Shipbuilders have been incorporated, with headquarters at Seattle, Wash., by I. M. Howell, G. W. Ninmire, W. S. Bradley and others.

The Columbia River Shipbuilding Company, Vancouver, Wash., will soon begin work on the construction of a plant.

The Barrett Shipbuilding Company, Mobile, Ala., has been incorporated by George S. Leatherbury, J. T. Schley, W. R. Turner and others.

The Gray's Harbor Motor Ship Corporation has been incorporated, with headquarters in Seattle, Wash., by W. J. Paterson, A. Schybach, M. R. Ward and others.

The Everett Shipbuilding Company, Everett, Wash., has secured a site for the construction of a shipbuilding plant. D. W. Locke is president.

The Falketina Shipbuilding Company, San Francisco, Cal., has been incorporated, with a capital stock of $275,000, and will erect a plant on San Francisco Bay.

The Union Shipbuilding Company, Seattle, Wash., is planning the establishment of a shipbuilding plant at Lake Union for the construction of wooden vessels.

Charles N. Crowell, Galveston, Tex., is stated to be organizing a company to build a shipyard at Beaumont, Tex.

The Tarver Shipbuilding Corporation has been incorporated, with a capital stock of $15,000, with headquarters at Beaumont, Tex.

The Sandstrom Shipbuilding Company, Seattle, Wash., has been incorporated to build a wooden shipbuilding plant. J. M. Farrell and Herman H. Sandstrom are among the incorporators.

The Raymond Shipyard Company, Raymond, Wash., has been incorporated by J. M. Frere, Wilmington, Del.; W. G. Shumway and C. B. Philbrick, of Raymond. It is stated that a site has already been secured.

The Marine Transportation Company, Mobile, Ala., has been incorporated by Peyton Norville, W. J. Norville and others to build submarine chasers.

The Anacortes Shipbuilding Company, Anacortes, Wash., is to be reorganized and enlarged.

The United Shipbuilding Corporation has been incorporated, with headquarters in Seattle, Wash., with a capital stock of $500,000. H. O. Guth and H. A. Bernardo are among the incorporators.

The Barrett Shipbuilding Company, Mobile, Ala., is planning to invest $300,000 in building a shipyard with the anticipation of securing Government contracts.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., is contemplating extensive improvements for the purpose of securing Government contracts.

The Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal., Samuel Naphalty, manager, has leased 70 acres of land and will soon begin the construction of its plant.

Eastman, Gardiner & Company, lumber manufacturers, Laurel, Miss., and Horace Turner, Mobile, Ala., are planning to build a shipyard at Mobile, Ala., with the anticipation of building ships for the Government.

Rolph Seeberg, Mobile, Ala., who is said to represent a syndicate of Norwegian capitalists, is planning to build a shipyard at Mobile.

The Wilson Shipbuilding Company, Astoria, Ore., has been incorporated, with a capital stock of $100,000, by J. P. Brix, Charles Wilson and others.

Capt. Varian C. Scott, Mobile, Ala., is reported to have purchased 20 acres of land, with the anticipation of erecting a shipyard to build Government vessels.

Sudden & Christensen, San Francisco, Cal., are reported to be planning the construction of a shipyard at Los Angeles.

Albert de Duiz, Long Beach, Cal., is negotiating for a site for the purpose of erecting a shipbuilding plant.

The Southern Dry Dock & Shipbuilding Company, Orange, Tex., has been organized, with a capital of $50,000, and is said to have already received a contract to build a four-masted schooner. S. M. White, of Orange, is president of the company.

The Old Dominion Marine Railway Corporation, Berkeley, Va., is planning to enlarge its plant, in order to provide for the wooden ships which the Government is ordering.

William E. Sehrs, Port Townsend, Wash., is planning the construction of a plant at Hadlock, Wash., for the construction of wooden vessels. It is stated that two contracts have already been received.

H. E. Heitman, Fort Meyers, Fla., is planning to build a shipyard, with the anticipation of securing Government contracts. The Fort Meyers Board of Trade is interested in the proposition.

Lincoln A. Gardiner and associates are reported to have purchased the old Crocker Shipyard, Stockton Springs, Me., and to have already secured a contract to build a four-masted schooner.

Charles F. Aulick and H. Coley Edwards, Tampa, Fla., are planning to establish a shipyard at Tampa, with the anticipation of securing Government contracts.

James G. Yates, Mayor of Port Tampa, Fla., has leased a site for a shipyard, in anticipation of receiving Government contracts.

The Bates-Hudnell-Jetton Company, Tampa, Fla., has secured a lease of land with the anticipation of securing Government contracts.

The Norfolk Shipbuilding & Dry Dock Corporation, Norfolk, Va., is constructing ways in anticipation of receiving Government contracts to build wooden ships.

The Florida Shipbuilding Company, Tampa, Fla., has been incorporated for the purpose of constructing wooden vessels. C. W. Deen, Lakeland, Fla., is president. J. M. Murdock, of Washington, D. C., is one of the directors.

T. M. Jones and A. B. McMullen, Tampa, Fla., are planning to organize shipyards for the purpose of securing Government contracts.

The Williams, Fair & Park Construction Company, R. M. Williams, manager, 154 West 131st street, New York, is planning to build a shipyard at Tampa, Fla., with the anticipation of securing Government contracts.

The Terminal Shipbuilding Company, San Francisco, Cal., has been organized, with a capital stock of $1,000,000, with the intention of building wooden vessels.

The Ward Shipyards, Olympia, Wash., are to be enlarged.

The Craig Shipbuilding Company, Long Beach, Cal., is to erect a frame machine shop on Channel No. 3.

The Brown Dry Dock Company, Morris street, Jersey City, N. J., has increased its capital from $50,000 to $100,000.

J. P. McDonough, head of the Galveston Dry Dock & Construction Company, says he will establish a shipyard on Pelican Island, and begin construction of seagoing vessels within the next 60 days. Another company may be formed to build the ships.

The Standard Shipbuilding Company, Vancouver, Wash., recently incorporated by W. C. McPherson, A. H. Devers, L. O. Elrod and Lloyd Bates, all of Portland, plans the immediate erection of a shipbuilding plant in Vancouver to construct wooden ships.

The Todd Shipyard Corporation have added to their New York plants the long-established Quintard Iron Works. The taking over of the Quintard Works was made necessary by the overflow of ship and engine repair work which now obtains. J. L. Lauder has been placed in charge of the offices of the added plant.

The Baltimore Dry Docks & Shipbuilding Company, Cross street, Baltimore, Md., has secured options on property at Spring Gardens, opposite its present plant at Locust Point, for a new shipbuilding plant as an extension to present works. The property consists of about 20 acres, with water frontage of about 600 feet. It is planned to build four new shipbuilding slips, with necessary shop facilities, to allow the construction of vessels about 600 feet in length and about 15,000 gross tonnage. A new drydock and floating dock are also contemplated, with railroad tunnel to connect the two plants. Day & Zimmerman, engineers, 611 Chestnut street, Philadelphia, Pa., have been retained to prepare preliminary plans. Holden A. Evans is president.

The Sunlight Building & Oil Company, Forty-ninth street and Gray's avenue, Philadelphia, is reported to have purchased a tract of about 200 acres of property on the Delaware River, Bristol, Pa., and plans for the erection of a large shipbuilding plant.

The Moran Towing & Transportation Company, 17 Battery Place, New York City, has acquired the property of the Southern Shipbuilding Company, formerly known as the Cole property, at Mill Creek, Staten Island, N. Y., at a price of about $50,000. The shipyard will be used by the Moran company for its scows, barges and dredgers, and it is said that a ship repair works will be constructed for company service.

The Southern Shipbuilding Company, Wilmington, Del., has been incorporated, with a capital of $10,000,000, to build a shipworks in Maryland. The Corporation Trust Company, Du Pont building, Wilmington, is agent for the organizers of the company.

During the past year the American Bridge Company has constructed six steel barges at its Trenton, N. J., works for the Lehigh Valley Railroad Company, the last having been launched a few weeks ago. The barges will be used as car floats in New York harbor; each is about 265 feet long and 40 feet wide, with weight of 600 tons, representing a cost close to $100,000. With the exception of the timber edges the entire barge is of steel. The local works are now operating at full capacity in the construction of ten additional barges of about the same size for the United States Government, Lehigh Valley and Pennsylvania Railroads. The largest of the boats will have a capacity of 24 freight cars. It is said that the company's business in this branch at the Trenton plant totaled over $600,000 during the last year.

Extensive Marine Terminal Improvements at Houston, Texas

The city of Houston, Tex., is spending over $900,000 on docks, wharves and other harbor improvements at Port Houston.

The city has just let contract for a modern concrete fireproof warehouse, 400 feet wide and 600 feet long, costing $150,000. Other improvements now under way are wharf No. 2, 504 feet long, 80,000 square feet, and wharf No. 3, 799 feet long, 24,000 square feet. These wharves will cost within the neighborhood of $189,224.

Wharf No. 4 is nearing completion; it is 777 feet long, covering 901,000 cubic feet and 96,850 square feet; this includes the apron, platform and shed space, costing $296,696.

The city will shortly ask for bids on wharf No. 5, and will also let contracts for additional tracks connecting with their Municipal Belt Line, amounting to about $15,000.

Steamboat Inspectors Instructed to Co-operate with Shipping Board

George Uhler, Supervising Inspector-General, Steamboat Inspection Service, of the Department of Commerce, has sent the following letter to United States supervising, local and assistant inspectors:

"As it is very probable that representatives of the United States Shipping Board will call upon you from time to time for assistance in connection with the prosecution of their duties with reference to shipping, you are directed, upon the receipt of such requests, to co-operate at once to the fullest extent with such representatives.

"You will bear in mind that at this critical time in the affairs of our Nation what is desired are results, and results must be obtained in every instance without delay, and the Bureau wishes to impress upon you that it desires the most hearty spirit of co-operation with the Shipping Board in connection with the great task that it has to perform."

Torsional Strength Test of 8-Inch National Pipe

In a test recently conducted by the National Tube Company, Pittsburg, Pa., a piece of 8-inch line pipe was subjected to a stress of 713,000 inch-pounds in torsion. The appearance

Section of 8-Inch National Pipe After Torsional Test

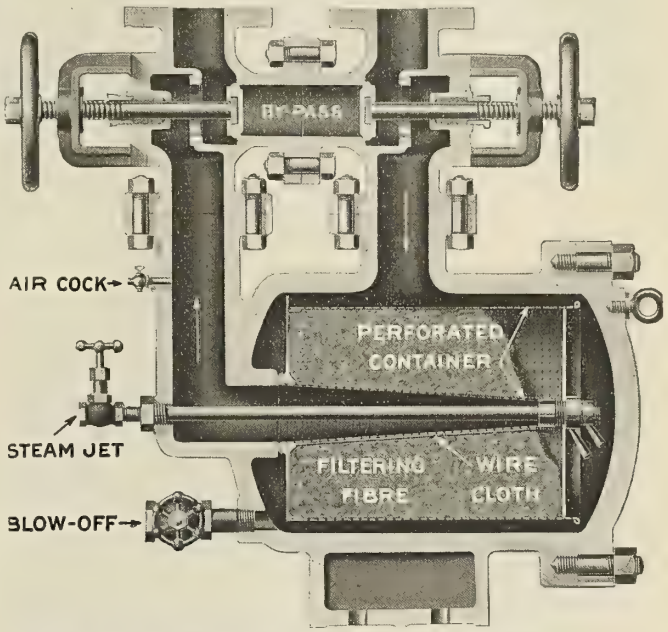
of the pipe, which weighs approximately 29 pounds per foot and has a wall thickness of about 1/3 inch, after being subjected to this strain, is clearly brought out in the accompanying illustration. The test specimen shows the homogeneity, ductility and high tensile strength of the steel.

R. & D. Feed Water Filter and Grease Extractor

The R. & D. filter, manufactured by Row & Davis, Engineers, Inc., 90 West street, New York, utilizes the affinity of coconut fiber for particles of oil, grease, scum and dirt, for the removal of these floating impurities from exhaust steam condensation and raw make-up water. Coconut fiber is peculiarly adapted to this work because of its high efficiency, low cost, suitability for re-use, and the fact that it is readily obtainable.

Referring to the illustration, the foul water enters the body of the filter, surrounds a cylindrical perforated metal container, percolates through the fiber (which retains the impurities), passes through a wire screen (which prevents escape of the fiber), and through perforations in a central conical tube which delivers into the outlet. The inlet and outlet valves are exactly alike, and so connected that the entire filter body may be removed without cutting off the boiler supply. The symmetrical construction of these valves and the location of inlet and outlet also permit of their valves being placed for insertion of the filter in a straight run of pipe, or if the feed pipe is located at an awkward point the line may be brought to a proper location for the filter by parallel inlet and outlet pipes.

A steam jet in the center of the outlet tube and a blow-off at the bottom of the filter body permit a temporary reversal of flow for steaming and washing out the worst impurities and for further efficient use of the fiber before its final removal for thorough cleaning. When the difference in pressure, as



R. & D. Feed Water Filter and Grease Extractor

shown on the gages on the filter body and the outlet, indicates that the fiber is clogged to an objectionable extent, a complete cleaning is effected by unbolting the filter cover, removing the container and inserting a charge of clean fiber.

To put the filter into operation, the air cock should be opened first; then the outer valve, which is farthest from the filter head, should be opened slowly to full opening; and then the inlet valve opened. The air cock should then be closed, and the difference in pressure between the inlet and outlet gages noted. After operation, until this pressure difference becomes 10 to 15 pounds greater than when the filter was first put into operation, the filter should be by-passed for steam cleaning. This is done by closing the inlet and outlet valves, opening the blow-off and turning on the steam jet for one to three minutes, which will boil out the grease and oil. This done, the steam jet should be turned off, the outlet valve slightly opened and the body washed out through the blow-out valve for about one minute. Closing the blow-out and opening the outlet and inlet, in the order named, put the filter into operation again.

Plate Planer for Edging Plates 40 feet Long and 1½ Inches Thick

The Covington Machine Company, Covington, Va., has recently built for the Standard Steel Car Company, Butler, Pa., a plate planing machine, for edging plates up to 40 feet long and 1½ inches thick. The machine weighs approximately 75,000 pounds. The frames are built with an open throat, so that plates longer than 40 feet may be planed by moving the plate forward. The machine is so designed that angles up to and including 8 inches by 8 inches of any length may be edged in the same manner as the plates by moving a section forward as soon as the first section is cut.

The drive screw, transmitting the power to the cutting head, is 48 feet long, 4 9/16 inches diameter, with a double lead Acme thread 1-inch pitch. The end thrust or reaction, due to the tool-cutting pressure, is cared for by two heavy ball bearings, one on each end of this screw, the arrangement of

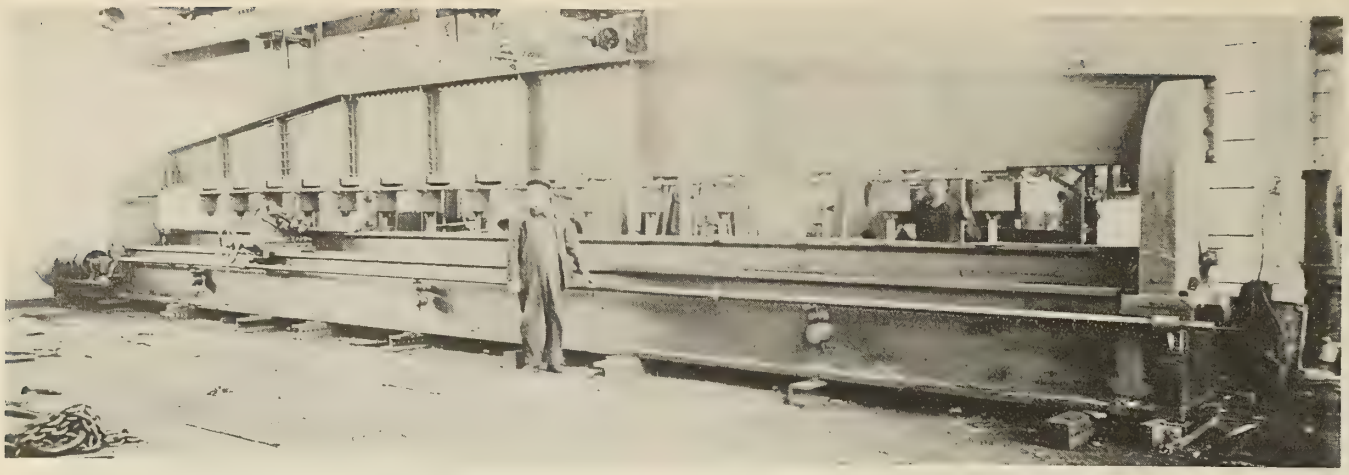


Fig. 1.—Covington Plate Planer, Designed for Edging Plates Up to 40 Feet Long and 1½ Inches Thick

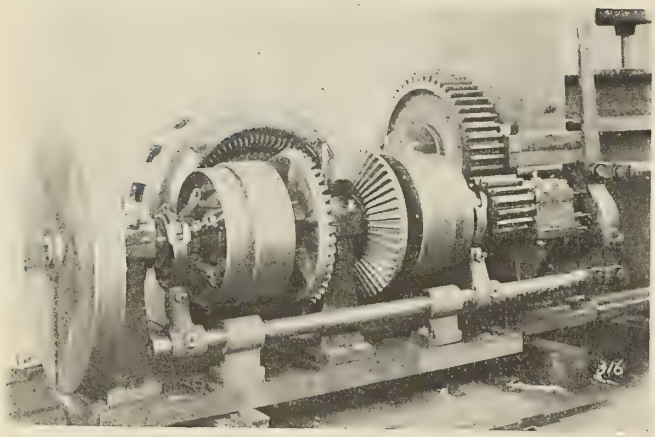


Fig. 2.—Motor Drive

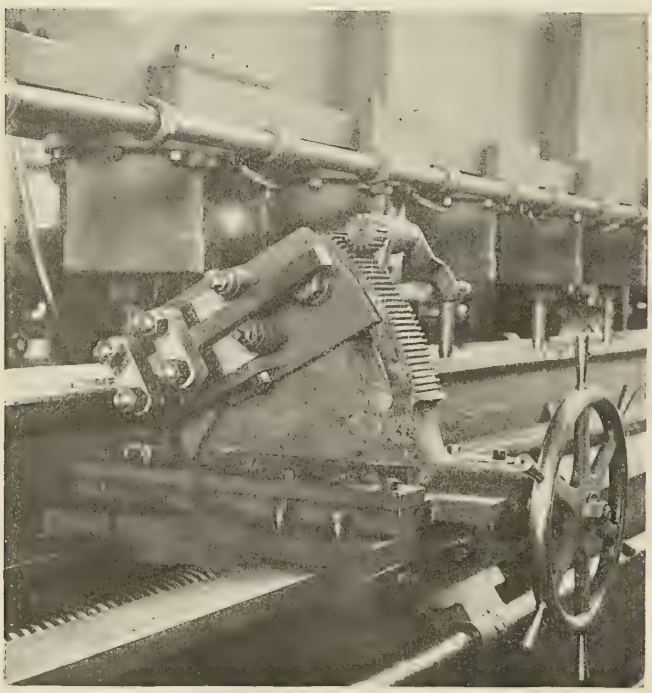


Fig. 3.—Cutting Head

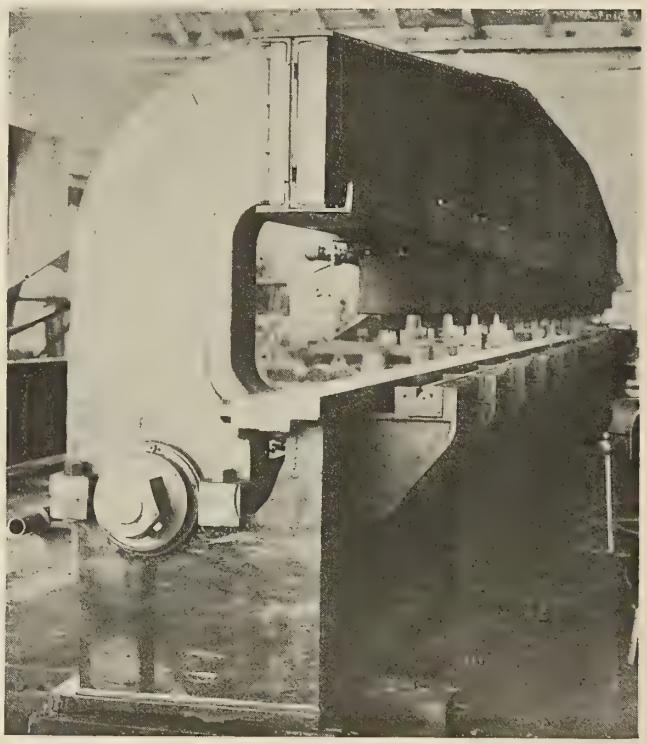


Fig. 4.—End View, Showing Open Throat Frames

the screw and thrust bearings being such that the screw is always in tension while carrying the cutting head. On the cutting head is mounted a bronze half-nut, engaging with the drive screw. The drive screw is supported for approximately one-third its circumference on the bottom its entire length. This support has extended flanges, forming a trough for flooding the screw with oil to insure lubrication at all times. At each end of the trough is a pocket for collecting the chips carried forward by the screw in its movement. Chips that are thrown out from the screw-bearing surfaces can be removed from the trough by hand or scraper while the machine is running or stationary. The end pockets are provided with large drain pipes so that the oil may be drained and filtered at any time. This also offers an opportunity for washing the screw and trough with cleansing oil, such as kerosene, at any time.

The cutting head consists of a steel casting mounted in cross feed guides on the carriage with two swivel aprons, one on each side of the cutting head. These aprons are pivoted upon a large pin bolt, which serves also as a clamp for holding the apron at any desired angle for cutting from 90 to 60 degrees. The tool holders are of the usual clapper box type on machine

planers, and are large enough to take a tool 2½ inches wide by 2 inches thick and of any length.

The cutting speed is 20 feet per minute, the maximum cut for a 1¼-inch plate being 1/16-inch feed, although it was tested for 3/32-inch feed.

The machine is motor driven. Reversing the drive of the screw is accomplished by two multiple-plate friction clutches. On the motor shaft is mounted a bevel pinion, which miters into the two bevel gears, running these continuously. The clutches are arranged to grip these gears alternately, to give the motion in either direction as desired. The motion for reversing the screw through the clutches is taken from the carriage, and a flywheel on the end of the clutch shaft is provided for keeping the carriage in motion when one clutch is thrown out and until the other is thrown in. The flywheel further serves while cutting to maintain a uniform power on the cut.

The side of the plate which is to be edged rests on rollers and a table cast integral with the frame. The plate is clamped in position by fifteen pneumatic jacks, each exerting a pressure of 5,000 pounds on a basis of 80 pounds per square inch air pressure. The air cylinders are piped up so that all may be thrown simultaneously, or any single air jack can be thrown separately.

In designing this machine the parts and clearances were arranged properly to take care of shipyard requirements.

Rivet and Bolt Head Cutter

The Rivet Cutting Gun Company, 220 East Second street, Cincinnati, Ohio, after exhaustive tests, has put on the market a pneumatic tool for cutting off the heads of rivets and bolts, and which is also intended to back the rivets out. The manufacturer claims that about 75 percent in cost is saved over the hand method of using a cutting bar and sledge, and that by the use of a long cutting tool rivets and bolts can be reached that are located where a scaffold would be requirel when employing the ordinary hand method.

The machine is operated by three men where heavy and quick work is required. It consists of an elongated cylinder in which there is a piston mounted on slides. At the lower end of the cylinder a cup-shaped casting is provided that carries the cutting tool. The shank of the tool is passed through the casting and projects into the lower end of the cylinder. It is fitted into a tool holder, between which and the end of the cylinder is a spiral spring to absorb any abnormal shocks, or, in other words, to take the impact of the piston in the event that the tool shank slips out of its holder.

Pneumatic Rivet Head Cutter, Weight 71 Pounds, Handled by Three Men

At the bottom of the cylinder is an exhaust port connecting with a pipe that leads back to the valve chamber at the top of the machine. This pipe serves also as one of the handles for the operators. By using a three-way valve the operator can reverse the pressure and force the piston back to the head of the cylinder, where another exhaust port is provided. A quick turn of the valve again forces the piston forward.

The machine operates successfully on air pressure of from 45 to 125 pounds. It is also used for punching holes in plates preparatory to reaming them to the correct size. In straightening sheets, the blunt end of a 1½-inch bar is simply placed against the sheet, and the machine started, which drives the sheet back into its original position. On ⅝-inch countersunk rivets in some places they are simply backing them out without cutting the countersunk head off. This saves time, and is done much faster than it originally was by the old method of drilling the head off.

Shipbuilding plants are using this tool for cutting off ¾-inch, 1-inch and 1¼-inch rivets on the hull of the ship, and then the backing out of these rivets is very easily accomplished with the tool. The advantage of this tool is about ten to one as against the bar and sledge on straight work.

Former Seattle Shipbuilder Organizes Two New Shipyards in Vancouver

J. V. Paterson, formerly president of the Seattle Construction & Dry Dock Company, Seattle, Wash., has been successful in the organization of the Vancouver Dry Docks, Ltd., and another corporation known as the British Pacific Engineering Company, both having their headquarters and sites for plants at Vancouver, B. C.

The British Pacific Engineering Company already has a contract for six submarines for one of the allied governments, and for those vessels steel has been provided and is either on the ground or on the way. Work is progressing most satisfactorily on the erection of the plant, and the first vessels contracted for are now under construction. It is likewise anticipated that other vessels, including merchantmen, will be under way shortly.

Full plans for the establishment of the Vancouver Dry Docks, Ltd., have not been completed, but an immense drydock capable of lifting the largest vessels will be built at the site, which will be convenient to all rail and water transportation lines of the British Columbia metropolis. In addition this company will have a new and strictly modern ship repair plant and will actively enter into that feature of maritime commerce.

PERSONAL

Herbert Christopherson, East Orange, N. J., has been appointed a member of the Naval Architect Board of the Government, in charge of ports between New London, Conn., and Barnegat, N. J., to arrange for the remodeling of yachts and pleasure boats for war service.

Henry J. Hartley, superintendent of the boiler department of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has retired from active duty. Mr. Hartley has been connected with the boiler department of the Cramp shipyard for the past fifty years, and since its organization he has taken an active part in the proceedings of the American Boiler Manufacturers' Association. Mr. Hartley was a recognized authority on the construction of marine boilers, and his work in this field is well known, not only in the United States but also abroad. Mr. Hartley is succeeded by his nephew, Victor Hartley, who has been appointed foreman of the boiler department at the Cramp shipyard.

Thomas Benson, formerly president of the Standard Shipbuilding Company, New York, has been elected vice-president and general manager of the Maryland Shipbuilding Company, Baltimore, Md. Mr. Benson was with the Harlan & Hollingsworth Corporation, Wilmington, Del., for twenty-five years, during that time rising to the position of general superintendent of the yard. Later he became chief engineer of the floating equipment of the Baltimore, Chesapeake & Atlantic and the Maryland, Delaware & Virginia Railways.

Major General George W. Goethals, general manager of the United States Shipping Board Emergency Fleet Corporation, announces his association with Messrs. Charles C. Jamieson, George H. Houston, Robert E. Graham, John C. Jay, Jr., and George M. Wells, consulting engineers, 40 Wall street, New York. The name of the firm will be Goethals, Jamieson, Houston and Jay, Inc.

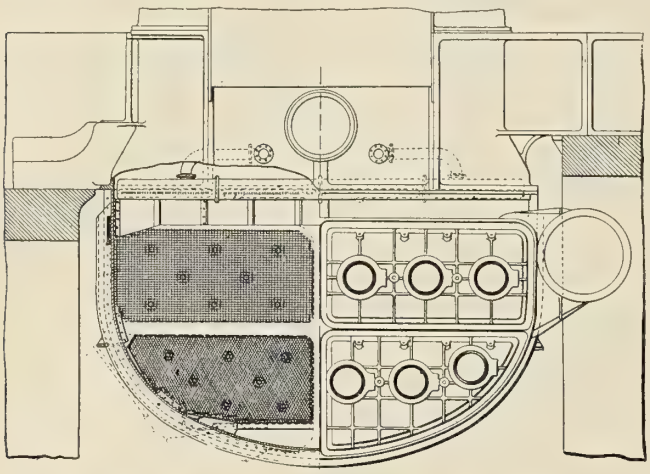
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,207,070. TURBINE INSTALLATION. CHARLES ALGERNON PARSONS, OF NEWCASTLE-UPON-TYNE, ENGLAND.

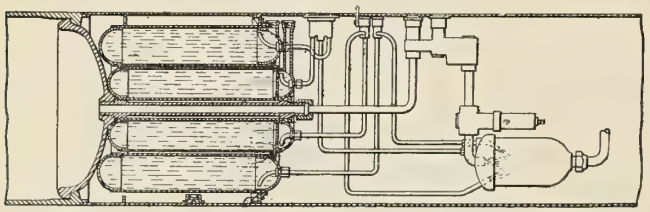
Claim 1.—An elastic fluid operated plant comprising in combination a low pressure turbine, supporting means separated by a space which is bridged by the casing of said turbine, a condenser receiving the working fluid discharged from the turbine, said condenser being situated in



the space below the turbine, means by which the condenser is suspended from the turbine casing, and preheating means partly within said turbine casing adapted to be impinged upon by the working fluid passing from the turbine to the condenser. Seven claims.

1,207,333. TORPEDO CONSTRUCTION. HAROLD W. SHONNARD, OF UPPER MONTCLAIR, N. J., ASSIGNOR TO CRUCIBLE STEEL COMPANY OF AMERICA, OF PITTSBURG, PA., A CORPORATION OF NEW JERSEY.

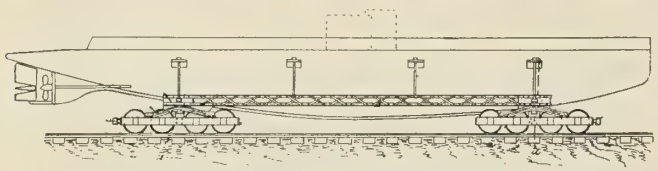
Claim 8.—In a torpedo, the combination of a shell, a compressed gas flask, a conduit leading from the flask substantially centrally of the torpedo shell, concentric annular fuel and water reservoirs surrounding said conduit, an inwardly-extending flange secured to said shell,



an outwardly-extending flange secured to the periphery of the outer reservoir and adapted to engage said shell flange, an outwardly-extending flange secured to the periphery of the inner reservoir and adapted to engage the outer reservoir, and a clamp adjustable upon said conduit and adapted to engage the inner reservoir and to thereby hold said several flanges in interlocking and reservoir-retaining positions. Eleven claims.

1,219,647. APPARATUS FOR TRANSPORTING SUBMARINE TORPEDO BOATS OVERLAND. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 1.—Apparatus for transporting boats overland, comprising wheeled trucks having bolsters provided with bearings, cradles pivotally



mounted upon said trucks by means of journals thereon fitted in the bearings on the bolsters and having a laterally loose connection therewith by king bolts, thereby to permit a limited lateral swinging motion of the cradles on the trucks, longitudinal frames connected to said cradles, and means to detachably secure a boat to the cradles and frames. Seven claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

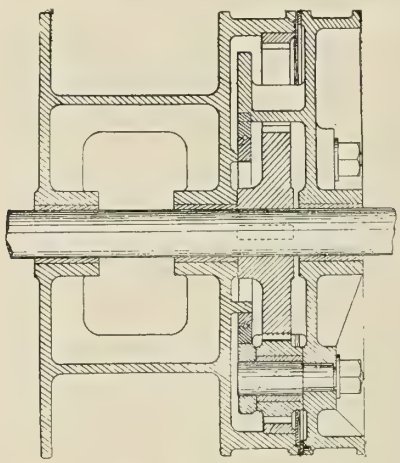
103,430. DEVICES FOR PROTECTING VESSELS AT SEA. P. J. D. DERKER, OF 108 LAAN VAN NEERDERVOORT, THE HAGUE, HOLLAND, AND J. EINDHOVEN, OF 54 RUE ST. LAZARE, PARIS, FRANCE.

This invention relates to those devices for protecting vessels at sea against mines which comprise horizontal cables stretched from bow to stern and connected at relatively large distances by vertical

cables attached to suitable brackets or booms. According to this invention the horizontal cables are tensioned by suitable winding devices at their ends, so that they are situated in a concave surface, as seen in a direction looking towards the vessel.

17,680/15. RELATING TO FRICTIONAL BRAKE AND CLUTCH MECHANISM FOR SHIPS' WINCHES. G. T. MACFARLANE, OF INNAMINCHA, CANNONS LANE, PINNER.

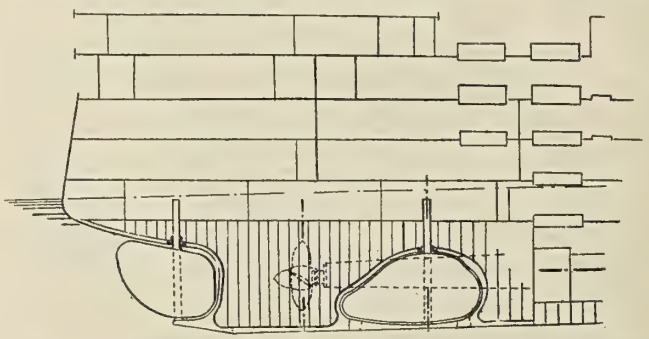
This invention has for its object to provide a winch in which the operations of raising and lowering loads can be effected with none or but little shock. For this purpose, in a winch comprising a barrel



and epicyclic gearing through which power is transmitted to the barrel, the braking of the epicyclic gearing drum is effected by means comprising a drum and a rope wound several times around the drum, one end of such rope being anchored and the other having a tightening pressure applied thereto, and overhauling of the barrel is obtained by bringing the drums into driving engagement one with the other, when braking restraint thereon is removed. The planet pinions of the epicyclic gearing are supported from the winch barrel as well as from the drum that carries them.

103,373/16. SHIPS WITH DOUBLE RUDDERS. E. C. R. MARKS, OF 57 AND 58, LINCOLN'S INN FIELDS, LONDON, W. C.

This invention has for its object to provide an improved arrangement of rudders in ships, and it consists in arranging two rudders in such a manner that while satisfying the requisite conditions for reducing the diameter of the turning circle of the ship, as well as the conditions for allowing the rudder to turn even through an angle



of 90 degrees relatively to the plane of symmetry, the improved arrangement will enable the ship to retain its original longitudinal profile. The aft rudder is arranged in the usual manner, whereas the forward rudder is pivoted in a recess formed in the longitudinal plane of the ship, with a contour approximately the same as that of the rudder itself. Between the rudders there is a thinned portion of the ship's bottom which serves as a support for that part of the hull situated between the two rudders. In order to facilitate the mounting and removal of the forward rudder, part of the keel may be removably attached to the hull by means of scarfing or fish plates and bolts.

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Speed Up the Building of Ships

WHILE the general public seems oblivious of the difficulties which must be overcome in providing an emergency fleet to offset the U-boat menace, shipbuilders have no such illusions. To them an emergency fleet means the progressive increase of output of shipyards and engine works. It means the expansion of a shipbuilding force of some 60,000 men into a shipbuilding force of from 150,000 to 200,000 men. It means the rapid expansion of existing shipbuilding facilities and the building of new shipyards. It means the prompt delivery of vast quantities of the various materials that go into the construction of ships. It means increased efficiency of production and, above all, it means the elimination of delays.

Two of the requisites for building an emergency fleet have been provided: Congress has appropriated the necessary funds and given the authority for carrying out the work, and steel makers and lumber interests have pledged the necessary materials. The United States Shipping Board Emergency Fleet Corporation, which is entrusted with the task of building this fleet, has spent the first three months of its existence principally with making plans; the actual construction of ships has scarcely begun. Contracts for something over 800,000 tons of vessels, including 38 steel ships, 34 wooden ships, 32 composite ships and 72 wooden hulls, have been placed. Most of the wooden ships will be of about 3,500 tons, while the steel ships range from 5,000 to 10,000 tons each; but the first of these ships will not be completed until February, 1918, and many of them will not be delivered until the winter of 1918-1919. At the rate at which the U-boat toll has been maintained since February 17 it is very apparent that not a moment's time can be wasted in building American ships.

Marine Oil Engines Wanted for Naval Reserve Officers' School of Instruction at Columbia University

THE engineering school for advanced naval engineering instruction at Columbia University, New York, is now being utilized for the training of officers of the Naval Coast Defense Reserve of the New York district. These officers are being given an intensive course to fit them at the earliest possible moment for the responsibilities involved in operating motor boats of the Coast Defense fleet, but owing to the lack in the laboratories of the university of large-size marine oil engines such as are to be installed on the Coast Defense patrol boats, Professor Charles E. Lucke, in charge of the instruction, has issued an appeal urging owners of engines of more than 100 horsepower to loan them to the school for the emergency period. Such engines may be shipped without any formality direct to Professor Lucke at Columbia University, 118th street and Broadway, New York.

Reinforced Concrete Shipbuilding—A Field for Pioneers

THE pressing need for ships and the existing congestion in American shipyards have led to a consideration of the possibility of utilizing other materials than wood and steel for shipbuilding. The most promising alternative is undoubtedly reinforced concrete, and already several prominent engineers have turned their attention to its application to the construction of ships. Various phases of the question are discussed in two articles published elsewhere in this issue.

Reinforced concrete ships are not a novelty. In San Francisco a firm of engineers is designing a ship with a length of 330 feet, a beam of 44 feet and a depth of 31 feet, with a capacity of 4,500 tons, to be built of reinforced concrete. As far back as 1898 a concrete schooner was employed for some years in the North Atlantic coasting trade. The London *Times* recently mentioned a small boat of reinforced concrete built by a Frenchman in 1849 which is still in service after a period of sixty-eight years. Concrete lighters have been used for the past six years on Chesapeake Bay, supplying coal and water to dredges carrying loads of sand and gravel, etc. A concrete barge has been in service on the Welland Canal since 1910 and has seen very hard usage. It has a length of 80 feet, a beam of 24 feet and a depth of 7 feet. The walls of the barge, which were constructed between forms, are 2½ inches thick, reinforced with steel rods. The barge has been used for carrying loads of stone, etc., with conspicuous success. Since 1910 reinforced concrete barges have been built for use on various sections of the Panama Canal, and their experience has enabled the engineers to develop a very efficient type of vessel. Recently concrete pontoons were constructed for service as landing stages for boats up to 65 feet in length. These pontoons have a length of 120 feet, a beam of 28 feet and a depth of 8 feet. They are very thoroughly reinforced.

Vessels which are much more like ships than barges have been built of reinforced concrete in Norway. A report from the American Consul-General at Christiania describes a plant at Moss, Norway, where vessels of 3,000 tons displacement are being constructed. At this place a concrete lighter having a displacement of 3,000 tons, which is being built for a mining company at Sydvaranger for the oversea export of iron ore and the import of coal, will be completed before the end of the current year. Two other lighters are now on the stocks and a large slip for a 4,000-ton craft is nearly completed. More than 200 men are now working in the new yards and five lighters have been contracted for in addition to the one completed and the two on the slips.

In view of such examples, proving the usefulness of concrete vessels of this character, the possibilities of constructing seagoing barges or other smaller craft suitable

for inland waterway traffic should be carefully investigated in the United States, for the substitution of such vessels for existing tonnage would in a short time release for other purposes many ships now used in domestic service. The presence of the necessary materials for building concrete vessels at so many convenient locations, and the ease and rapidity with which they can be built by unskilled labor, would seemingly make it possible to provide a large tonnage of such craft in a relatively short time.

Progress in the development of seagoing concrete steamships must necessarily be slow at first, as real information is lacking as to how such vessels will stand up under shocks. Seafaring men who have handled vessels in North Atlantic winter storms or in West Indian hurricanes realize that such information cannot be gained from laboratory experiments. The behavior of actual concrete ships under power in a seaway must be studied.

Transportation on Inland Waterways Must Be Developed

Owing to the fact that to-day the railroads of the United States are carrying more freight than ever before in the history of the country, and that the total railway transportation facilities now available will be insufficient to handle the tremendous volume of freight which must be transported for war purposes in the immediate future, the Department of Commerce has issued an appeal for the immediate development of transportation on our inland waterways. No one who knows the facts will question that the railways of the country are overwhelmed by the present traffic. There is said to be a shortage of 150,000 cars. Although radical measures are being taken by the railroads in the effort to meet the situation by curtailing passenger traffic, installing new locomotives and cars as rapidly as they can be built, and regulating traffic so as to secure the most effective use of the equipment which is available, nevertheless, even with the universal application of such measures, the facilities of the railroads will soon be entirely inefficient for the task laid upon them. Under these circumstances it is necessary that every possible use be made both for local and through freight of all interior waterways, canals, rivers and lakes, and this must be done not only as generally, but as quickly as possible, if transportation facilities are to escape serious congestion and if our part in the war is not to be seriously hampered.

For years many of the great waterways of the land have been practically unused. The railroads have been antagonistic to the development of inland waterway transportation, and without co-operation with the railroads no development of the waterways has been possible. With the new order of affairs introduced by the war, however, there can be no question of the mutual advantage to the railroads and to the communities bordering on inland waterways which can be secured by utilizing the facilities which the inland waterways offer for transportation.

It is to the interest of the cities and towns on waterways to take immediate steps to encourage water transit and to extemporize, if need be, means for bringing it quickly into service. Every river, lake and canal should be used. Every enterprise, large or small, looking toward their practical use should have the encouragement not only of the cities and towns which they serve, but also of the railroads feeding such waterways. The problem is not only an economic one, but it is a patriotic one. It means that everyone who has available floating equipment which can be used for cargo transportation on inland waterways, whether in the form of barges, motor boats or river or lake steamers, should immediately take steps to make this equipment available for transportation purposes. Numerous boat building yards exist, especially on the large western rivers, which for years have been operated at small capacity, or have been practically idle. These yards should be built up and extended. New yards should be built. Engine and boiler manufacturers should prepare to co-operate with the boat builders and make it possible to create in the shortest possible time tonnage suitable for transporting both bulk and miscellaneous freight on the adjacent available inland waterways.

The movement to utilize the inland waterways has the approval of the War Department, the Commerce Department and the Shipping Board, and a committee under the advisory commission of the Council of National Defense has been formed to advise in promoting the immediate use of all inland waterways. This committee consists of the following: George E. Bartol, president of the Philadelphia Bourse; Brigadier-General William M. Black, Chief of Engineers, United States Army, Washington; Captain J. F. Ellison, Cincinnati, Ohio, former secretary of the National Rivers and Harbors Congress and late general manager of the Amazon Navigation Company; Joy Morton, Chicago, Ill.; James E. Smith, St. Louis, Mo., president of the Mississippi Valley Waterways Association; Walter S. Dickie, Kansas City, Mo., president of the Kansas City-Missouri River Navigation Company, and M. J. Sanders, president of the New Orleans Board of Trade and representative for many years of the Leyland Line of steamers.

Sea-Going Yachts Needed for Immediate War Duty

In connection with the quiet campaign of preparedness which is being carried on under the orders of Franklin D. Roosevelt, Assistant Secretary of the Navy, and about which there has been no previous public announcement, an active effort has been under way during the last month to procure sea-going yachts for immediate war duty. Vessels of this kind must be not under 110 feet in length, with sea-going ability and of large cruising radius. The Government will employ a large number of such vessels as auxiliaries to the other fighting units of the navy, and the patriotic spirit of many owners who have already come forward to turn over their vessels for this valuable service is worthy of commendation. Not only from ports on the Atlantic Coast but from various points on the Great Lakes a fleet is being rapidly mobilized, and a number of fine yachts, now in process of alteration, will very shortly be added to the fleet of the navy.

About a month ago the Assistant Secretary of the Navy organized a Special Board for Patrol Vessels, whose duty is to secure suitable boats with all possible dispatch. One of the first moves of this Board was to have the International Mercantile Marine Company, 9 Broadway, New York City, designated as the official agents of the Special Board. This brings to the assistance of the navy in these times of stress the services of the International Mercantile Marine Company's large staff of shipping experts, all of whom are giving their services without remuneration. The navy yards, in their present crowded condition, are thus relieved of a great deal of work, and under this new arrangement owners also are assured of immediate pay-

ment for their boats, dispensing with the time-consuming formalities which ordinarily are followed in dealing with the Government departments. The International Mercantile Marine Company is also supervising all alterations above and below decks, arming, outfitting, coaling and provisioning the ships and delivering them, painted in war colors, to the Navy Department for sea duty. The Special Board for Patrol Vessels is acting in an advisory capacity and is preparing to man all these ships promptly. Such well-known yachts as *Carola IV, Nokomis I, Emeline, Wanderer, Corona, Zara, Remlik, Sialia, Alcedo,* have already been taken over by the Government and are in process of alteration.

There is at present before Congress a bill authorizing the requisitioning for this special sea service all available boats of suitable size and other qualifications, but before this law becomes effective the Special Board for Patrol Vessels and the International Mercantile Marine Company would be very glad to hear from any yacht owner who cares voluntarily to offer his craft for service against the enemy. The work to be accomplished is of an extremely important military nature, so that any owner placing his boat at the disposal of the Government will render the greatest possible service, and, owing to the arrangement with the International Mercantile Marine Company, will receive payment without delay or formality.

Yonkers to be Developed into a Modern Port

The city of Yonkers, N. Y., is preparing to have a modern port terminal equipped with up-to-date harbor facilities and mechanical appliances. Mr. H. McL. Harding, formerly consulting engineer of the Port of New York and now consulting terminal expert for the Barge Canal Terminals of the State of New York and president of the Society of Terminal Engineers, has been appointed consulting engineer to prepare plans and designs.

Yonkers has about 4½ miles of linear waterfront now partially developed, which, when fully improved by diagonal piers, will give at least eight miles of ships' berths. When a port is not equipped with freight-handling machinery about 150 tons of freight per linear foot per year is the average transferring capacity, but when properly equipped 450 tons per foot can be transferred. This increases the workable value per linear foot by three, and is equivalent in results to extending the frontage by three, or the eight miles of ships' berths at Yonkers equipped with freight-handling machinery would be equal to twenty-four miles of the usual waterfront. Waterfront space in the United States is rarely furnished with mechanical facilities, while every port in Europe, small or large, has traveling gantry cranes supplemented by other machinery.

Quays will at first be developed on the unit system, whereby each length of approximately 500 feet will constitute a unit, and thus will have a frontage with a concrete quay wall. There will be close co-ordination between the ships and cars, the railway tracks being parallel to the water's edge. The holding traveling gantry cranes will span the space for these railway tracks and drayways. The holding sheds will be of steel, and not only in front but behind the sheds, between the sheds and the six-story concrete warehouses, will be additional car tracks and drayways, and back of the warehouses the connecting railway tracks and the marginal way will afford connections between all the units of the terminal and the tracks of the main trunk lines.

As the waterfront of Yonkers is but an extension of the shore line of the Port of New York, there will be a continuation of quay and piers, but with this difference—the Yonkers waterfront will be thoroughly modern in design and equipment.

Submarine and Airship Base Sites on the Pacific Coast

The Secretary of the Navy has made public the recommendations of the Commission on Navy Yards and Naval Stations relating to the selection and development of submarine and aviation bases on the Pacific coast.

The commission recommends that San Diego be developed as the main training station for aviation on the Pacific coast, that all or any portion necessary of North Island, in San Diego Bay, be acquired for this purpose, and that $500,000 be appropriated for development, in addition to the amount found necessary for the acquisition of the land. Stating that it has been unable to obtain satisfactory information as to the value of the property and that the owner in a letter named $4,500,000 as the purchase price, the commission adheres to its former recommendation that the Secretary of the Navy be authorized to obtain this site by condemnation or by such other proceedings as may appear advisable after determination of the Government's interests in the property. For the development of an operating submarine base at San Diego, to be located upon the existing naval reservation, and capable of accommodating at one time at least six submarines, it recommends that $375,000 be appropriated.

The commission repeats its previous recommendation that the Secretary of the Navy be authorized to accept a tract of 166 acres of submerged land in Los Angeles harbor, known as site No. 1, which has been offered to the Government free of charge by the city of Los Angeles, and now recommends that $2,500,000 be appropriated for the development of a submarine base on that property. It is also recommended that $250,000 be appropriated for the establishment of an aviation operating base on this same property at Los Angeles.

The commission has received from the harbor engineer of Los Angeles a statement that the value of this site which the city offers to donate free of cost for naval purposes will be $4,000,000 when it is reclaimed, and, further, that a saving of from $400,000 to $500,000 would be effected by the Government in the actual preparation of the site if acceptance be made immediately.

The commission states that general plans and estimates for the development of a home base for submarines and an aviation station at Mare Island Navy Yard, Cal., have been worked out, and it recommends that $490,000 be appropriated for the development of the submarine base and $540,000 for the aviation station.

Plans and estimates for the development of a home base for submarines and an aviation station at the Puget Sound Navy Yard, Wash., have also been completed, and it is recommended that $1,425,000 be appropriated for the submarine base and $375,000 for the aviation station.

For the development of a submarine and aviation operating base on Ediz Hook, opposite Port Angeles, Wash., on ground already owned by the Government, it is recommended that $300,000 be appropriated.

For the establishment of a submarine and aviation base near the mouth of the Columbia River, the acquisition of a site and its development, the Commission recommends that $1,200,000 be appropriated and that legislation be enacted authorizing the acquisition of such site as may be recommended as most suitable by the commission and approved by the Secretary of the Navy and the President.

LETTERS TO THE EDITOR

Sources of Information

Due to the lack of practical experience of the majority of ships' draftsmen, and their lack of knowledge of costs that is to definitely determine between alternate methods of construction, the following editorial from *Engineering*, October 6, 1916, on Mackrow's "Pocket Book," gives the viewpoint of editors of a plan by which draftsmen may be supplied with this necessary information.

"To the present writer it has always seemed that, while the information contained in the Pocket Book under review is exceedingly comprehensive in its variety and scope and of the highest utility to the draftsman and designer, there is room for an extension of its sphere of usefulness in the direction of pointing out the practical considerations which should underlie and govern good design. Too often it is found that plans issued from the drawing office to the yard are drawn out with little or no regard being paid to the practical difficulties or cost of the construction shown. Inaccessibility for riveting or calking, or for subsequent cleaning and painting, are very common forms of this trouble. Reduction in the amount of smithed angle or furnaced plate work is another point too frequently lost sight of by the designer, with consequent increase in cost of labor and loss of time in the yard or shop. It may be contended that this does not properly come within the scope of a pocket book, but the fact that a copy of Mackrow is to be found in every drawing office, and is, indeed, regarded by draftsmen as almost part of their equipment, is the best proof of the suitability of this medium for distribution of information of the nature suggested. Such information is occasionally to be found in text-books, but these are not generally available, and it would be of great value to have it included as an addition to the book.

"Data regarding oiltight and watertight packings and injection compositions, modern composition substitutes for wood decks, new types of boat davits and life-saving rafts, acetylene and electric arc welding and other points that readily suggest themselves to the mind and which would be of very great service to the shipbuilder, would add to the value of the book and might, in the opinion of the writer, be advantageously inserted in place of some of the tables of dimensions of blocks, hooks, etc., or Lloyds Rules for masts and rigging."

The foregoing comment points out the necessity of such information, but the suggested source of information covers a very limited scope. It is believed that as equipment is entirely dissimilar in every yard, the idea of hard and fast rules being established for methods of construction hardly seems feasible. Methods soon become antiquated and it is not likely that the author of a hand book should care to go on record as to published methods until the next revision of the book. There is a medium, however, through which matter of this kind may be presented, and that is through a magazine; contributions from this source will be received from all connected with shipbuilding and not confined to a few; the tendency, then, is to keep the readers (which should be all whose work has any bearing on maintenance, cost, construction, and design) constantly posted as to improvements. A hand book may contain many practical suggestions as to alternate methods of construction, but to realize the lowest cost and overcome the practical difficulties that arise in each design, the best available mechanic should check drawings before they are sent into the yard. Who is better fitted to criticise and offer suggestions as to ways and means of overcoming these difficulties than the man who has fitted ungainly tuck and boss plates, set up on holding down bolts when the nuts always seem to foul the fillets of angles, and hammered tight-fitting flanged plates that should have been angle connected?

An outside man checking drawings establishes the link in an existing gap between the yard and drawing room whereby the draftsman's information and references (past plans of similar work) are soon brought up to a standard of best practice.

Balboa, C. Z. WILLIAM M. KENNEDY.

The Marine Oil Engine

In the June, 1917, number of MARINE ENGINEERING were two very interesting articles on the oil engine, one on page 244 entitled "Largest American Marine Diesel Engine Installation Proves Successful," and the other on page 261 entitled "Relative Failure of the Marine Diesel Engine."

It would be interesting to know who authorized this statement of the successful operation of the engine covered in the first article. At the bottom of the page we read: "The only defect that has developed has been the cracking of some of the cylinder jackets, which is apparently due to lack of sufficient clearance between working liners and jackets." It is my understanding that this two-cycle type of engine has been removed from European vessels for just this sort of success. It is hard to see how an engine in which castings crack in five months' service can be called successful.

About all that there is of note in the second article is the reference to high pressures. The necessity of high pressure has been shown to be a false theory. Yet here we have the same point cropping out again. We see the cylinders compared to cannon barrels. Heavy oil can be ignited on pressures of compression not far from 100 pounds. In fact, I have a card in my possession where ignition occurred at 70 pounds.

Interesting developments in the oil engine field have been promised within a few months. It is hoped that the design used for the basis of this new start will not be a German design, neither will ordnance firms have to design the cylinder.

Quincy, Mass. JOHN F. WENTWORTH.

What Makes the Gasoline Engine Stop?

SPARKSVILLE, June 9.

Gents: The gas engine you sent me stops when theres nothing the matter with it thats the trouble. It wouldent bee so bad if it stopped for some reason and anybody knows theres reasons enough for it to stop. and why cant it pick out one of them reasons for stopping instead of stopping for no reason at all so that no one cant find the reason because you cant find the reason can you when ther aint no reason thats common sence aint it.

I received the book which you sent me which is named What Makes the Gasoline Engine Go. I aint read it yet be-cause whats the use reading it when I dont care what makes the gasoline engine go as long as it goes which mine dont only occasionally when not particularly needed but when just experimenting or something. what I want to know is What Makes the Gasoline Engine Stop. if you got a book called that send me one and thats what I want to know particularly what makes my gasoline engine stop when everything is o k and nothing is the matter except that it must be a rotten engine.

HIRAM DIGGS.

The Future of American Shipbuilding

Present Activity Marks Beginning of Permanent Expansion of American Shipbuilding Industry—Trained Men Required

BY ARTHUR F. JOHNSON

THE unprecedented activity in American shipbuilding, with attendant prosperity and investment of capital, will if appropriately carried forward mark the beginning of a permanent and extensive future prosperity for the industry.

The enormous expenditures involved in the new and modern equipment, the affiliation of numerous yards, their intimate relations with or actual domination by the larger steel firms, the education of an immense force of laborers and the awakening of national interest and realization of the blunders committed in the past, all heighten the probability of shipbuilding becoming a prominent future calling in this country.

We cannot build up such a tremendous structure for immediate profit and overthrow it at will, returning to former ways and conditions. Financial ventures of such character have proven themselves inadvisable and will no longer be tolerated. Shipbuilding cannot be considered a "war bride" while we have the knowledge that it can be successfully conducted when peace is declared.

Regardless of excess cost in materials and labor, scientific management will surmount the handicap of foreign competition, as it has done in so many of our other large manufacturing industries. That there will be competition is undoubted, but it is likewise certain that foreign labor will demand increased compensation to offset the burden of taxation imposed to meet expenses in the present conflict.

Certain it is also that many of the yards created here to meet the emergency will be forced to shut down when the demand for new tonnage returns to normal. This will not be immediately upon declaration of peace, however, nor within several years subsequent thereto. It will occur only when the total destroyed tonnage has been replaced and the requirements for new ships can be met by a proportionally decreased number of shipyards.

Efficiency of Shipyards Will Increase

The efficiency of our established shipbuilding plants is marked, but there is no reason to negate its possibility of increase. We are now admittedly building ships more rapidly than England, and such admission on the part of the world's greatest shipbuilding country is a compliment to American system.

If we are to build ships at a profit when orders are no longer so plentiful, account must be taken of the constant or increasing cost of labor, to offset which methods must be improved, number of laborers employed reduced by substitution of machinery where possible, standardization in degree compatible with progress introduced, and the whole industry conducted on strict principles of scientific management.

The accomplishment of these ends would have been practically impossible before the present ship shortage made itself felt, principally because of the traditions connected with ships and their method of building. The profession is one of the oldest and its products are operated apart from observation of the builders by a distinct group, the seafaring men. These limitations of environment prohibit the discussions between builders and operators for purposes of improved design, resulting in adherence to many needless and expensive details in construction.

The building of ships scientifically calls for elimination of every feature tending to increase cost and needless complicity of construction. Furnacing and bending of plates and shapes must be minimized, as must the introduction of many features whose sole merit is the so-called "improvement of the vessel's appearance."

A feature even more important is the recognition of the profession of naval architecture. The scientific production of vessels will call for a maximum of technical talent. The word "technical" here does not imply theoretical only, but practical as well. In fact, the ability to temper theory by limitations of practical consideration is the true measure of a technical man.

Education of Naval Architects

The educational methods at present followed by us must be modified to produce the men who will be best fitted to organize and operate the shipyards in the future, when confronted by keenest competition. That such changes are desirable is testified to by the justifiable reluctance evinced by many firms toward the employment of newly graduated technical men, the reasons for which are twofold.

Primarily the graduate's attitude toward the profession is too theoretical and often he hasn't the least conception of practical shipbuilding as conducted in the yards. When first taken into the company's employ he must revise his ideals and accustom his mental attitude to the limitations imposed by practice. His knowledge makes him best fitted for employment in the drafting room or mold loft, calculations being his hobby. Even here his first year or two is at the expense of the shipbuilding firm.

Secondarily, the graduate is blind to his faults, ordinarily imagining that "science" as applied to ship work began when he received his diploma. He overestimates his assets and underestimates those of the practical men around him. A certain percentage of this latter trait may be attributed to the eternal egotism of youth and can never be suppressed except through experience gained with age. A much larger percentage of it is doubtless due to the academic nature of his college course and could have been avoided by an injection of the strictly practical in moderate amount, a remedy possible only through co-operation between shipbuilding firms and the faculty members.

Another explanation, and this of the antiquity of some of the small amount of the student's practical knowledge, is that texts are necessarily somewhat behind in methods treated of, having been written only to cover standard practice, and that in most general terms. There is no thorough treatise on the practical art of shipbuilding as conducted on this side of the Atlantic, and the only feasible plan to afford the required information would be by direct study of the yards in proximity to the technical school.

A university or technical school is not conducted with a view to financial gain, and the proper furtherance of its courses necessitates employment of elaborate equipment, the expense of which cannot be covered by tuition and incidental charges. To attempt this would render charges

of magnitude prohibitive to registration of the majority of the students anticipating a technical career.

Most technical students are of moderate means, in direct opposition to the prosperous majority of those undertaking academic courses. The irony of this relation is enhanced by the fact that the expense of maintaining a technical course is much greater than that in the case of an academic one.

Much of the present equipment in technical school laboratories has been generously provided, through direct contribution or considerable reduction in price, by the manufacturers. The shipbuilding firms of this country should take an active and collective personal interest in the laboratory equipment of our schools in naval architecture and marine engineering, and such action should not be considered in the nature of unprofitable investment. They must not anticipate a corps of graduates fitted to step into their concerns, and promote their welfare, unless those concerns put forth every effort to promote the efficiency of the technical courses.

Such conduct applies in equal measure to the faculty of each technical institution. Those responsible for instruction of future naval architects must not stand aloof from personal and ceaseless effort to govern the dissemination of information by the ever-changing requirements as set forth by progress of the industry.

Co-operation of Schools and Shipbuilders

One of the prominent schools in naval architecture has started work along these lines by soliciting the advice of prominent shipyard executives. The same generous men would, it is felt, serve in similar capacity every like institution in the country. There are not many such schools and they are well distributed geographically. It is but a question of approaching the leading shipbuilding firms, who will gladly put forth every effort to advance the profession. Their advice is essential, and their gain would be considerable, if each institution were properly equipped to conduct tests and investigate problems of direct practical value to the industry. Many vexing and expense-increasing obstacles are constantly encountered in the shipyards, to which the firm cannot devote time, but which could be quickly and efficiently eliminated if referred to the laboratory of the nearest school in naval architecture.

The experience gained by students solving these difficulties would put them in closer touch with actual working conditions and render them better fitted to step into harness upon graduation.

If the various shipbuilding firms would constitute themselves into groups centered about the institution closest to their plants, each group to be represented by a committee which would include representatives of the faculty, much could be done toward improving the conduct of both plants and institutions.

The period of so-called "trade secrets" has passed, and with it the false standards of efficiency set up by adherence to a fixed procedure closed to outside suggestions for improvement.

The personnel of future technical men and their derivation are worthy of careful thought. Many youngsters entering a course in engineering have not the remotest idea of its purposes and scope, which accounts for the numerous failures to complete the course or, in event of graduation, the big percentage of those who make little or no progress. A requisite for success in engineering is the ability to create, to foresee possibilities, to eliminate wasteful conditions and to conserve energy.

If a larger percentage of engineers were recruited from the brighter youths employed in industrial plants, the profession would be benefited, for, having seen the practical workings of the industry, these youths would be in position to gage their interest in it as a life vocation, and thus obviate the waste of years, and possibly a lifetime, in a calling unsuited to their particular temperament.

If the larger and permanent shipbuilding companies were to establish scholarships at the schools of naval architecture and marine engineering, financing the project by loan to the students or through a fund with the university, and selecting candidates from the youths in yard, shop and drafting room by competitive marks and tests, the esprit du corps would be elevated and a higher class of men would seek affiliation with the industry. Another of the numerous advantages of such procedure would be the development of technical men suited for work outside the drafting room or mold loft.

The shipbuilding industry in this country is well advanced, considering its besetting difficulties in previous normal times. An avoidance of similar conditions after the present boom can be brought about only through the most efficient and farsighted procedure. It will prove advantageous for us to seriously consider some program in essence here outlined, with the added feature of graduate student courses as conducted by the large manufacturing companies in this country.

Steamboat Inspection Rule for Licenses Is Modified

Telegrams have been recently received by the Board of Supervising Inspectors of the Steamboat Inspection Service of the Department of Commerce, from towboat and tugboat owners of Puget Sound and other western points, urging that some action be taken relative to modifying the rules as to admission to license of masters, mates and assistant engineers of craft plying such waters. The telegrams stated that owing to high wages being paid by the navy yards and shipyards, it was impossible to keep licensed mates and engineers. They could get from $6 to $9 per eight-hour day and overtime, and the result was that it was becoming increasingly difficult to obtain enough men to operate their craft.

After considering this matter, the executive committee of the Board of Supervising Inspectors issued the following order: That for the present and until further notice, sections 20, 21, 23, 26, 31 and 32 of Rule V, General Rules and Regulations Applying to Lakes (other than the Great Lakes), Bays and Sounds, be struck out and local inspectors notified that hereafter in issuing licenses to officers of vessels within this classification, they may exercise the judgment and discretion vested in them by law, without regard to the experience required by the rules and regulations, the sufficiency of such experience to be determined by the local inspectors when a candidate applies for examination.

The effect of this order, which has been approved by the Secretary of Commerce, is to modify the rules for experience and make it much less difficult to obtain a license. In other words, if the local inspector considers a man qualified to stand the examination but is lacking in experience, he may examine him.

The order affects masters of steam vessels in the territories indicated, and also mates, pilots and chief and first, second and third assistant engineers. The order applies to Chesapeake Bay, the Potomac River, Long Island Sound, Delaware Bay, Pamlico and Albemarle Sounds, Mobile Bay, Lakes Ponchartrain and Maurepas and other sounds and coast waters.

The first class in Uncle Sam's chain of navigation schools to prepare officers for the merchant marine. This school was opened at Harvard College, June 4. Others are being opened at Atlantic Coast ports. Later the Gulf and the Pacific Coast will have similar schools. Not less than 5,000 deck officers for the new blockade running fleet of 1,000 merchantmen will begin their training in these schools

A Call to American Seafaring Men

Navigators and Engineers Wanted for the United States Emergency Fleet—Training Provided by the Shipping Board

A CALL to American seafaring men, in behalf of the Merchant Marine, has been issued by the National Government through the United States Shipping Board. The Government wants the services of every man now free to enroll who can qualify as a watch officer or has a fundamental knowledge of engines or engine room duties. It will need in a few months 10,000 officers for the large fleet of cargo ships to be constructed for the Shipping Board. These ships are to be the nucleus of a new, nationalized fleet that eventually will carry the flag to every quarter of the globe and put the country where it belongs—among the maritime nations of the earth.

This fleet is actually under construction, and the fact that the construction work has been entrusted to Major General George W. Goethals, the man who dug the Panama Canal after it had broken the purse of its French backers and the hearts of many trained engineers, is evidence that the job will be completed as planned.

Pressing Need for Men

The Government's most pressing need for its new fleet is not, in fact, ships, for those are assured, but men. There are not 10,000 merchant officers in this country, nor yet 5,000. But there is the raw material for officers at every American port.

Americans are notably adaptable, and on this fact the Government bases its faith that the officers needed to supplement those now in service can and will be found among the hosts of clean, dependable, intelligent men not enrolled in the navy, who know something of the water. In every port of the United States one sees such men on board small craft of every sort—on tugs, ferryboats, passenger steamers plying harbors, lakes and sounds, or sailing vessels, both coasters and fishermen, and in the crews of larger coastwise steamers.

Class of Men Wanted

Most of them occupy modest positions. A good many have never dreamed of command on an ocean-going ship or of a berth as a first officer or engineer on such a ship. They have not enough faith in themselves, perhaps, for want of encouragement, to believe they could make good in such a position of responsibility.

But Uncle Sam thinks they can make good. He is telling them so by every means possible, as fast as he learns where they may be reached. In order to impress on them their value to their country at this time, and the welcome they will receive in the new merchant marine, he has established a recruiting service for the Shipping Board.

At the head of this service has been placed a trained organizer, Henry Howard, of Boston. Mr. Howard, who is a business man and a yachtsman, is entirely familiar with the needs and traditions of the merchant marine.

Mr. Howard advanced to the Shipping Board a few weeks ago a comprehensive programme for utilizing the country's splendid material for merchant officers. Having a perfect knowledge of the coast and conditions in maritime communities, he told the Board that there were enough men of the best type available to officer the new ships being built for the Board by General Goethals, and

all others now building that the Government may take over.

The Board heard Mr. Howard's statement with receptive interest, authorized him to go ahead and made him director of recruiting for the Shipping Board, with full powers to enlist and train the 10,000 officers that the Board ultimately will need. Since taking office Mr. Howard has made a widespread appeal to recruits through the daily press and class papers read by the type of man he wishes to reach.

Already a large number of recruits have come forward for positions, sending their names to Mr. Howard's headquarters, which are at the Custom House, Boston. As fast as names come in they are filed and each applicant, if he has had seagoing experience of three years, is sent information of the plan to be followed in fitting applicants for service.

Instructors in School of Navigation. To the left, H. W. Geramanos, Dean of Engineering School, North Easton College. To the right, Prof. G. L. Hosmer, Harvard

The Government does not ask the applicant to plunge unprepared into the work reserved for him. It is ready with a practical means of aiding him to fit himself for the new job. These means consist of schooling and training, the expense of which the Government takes upon itself.

Training Proposed by Mr. Howard

A system of training was outlined in Mr. Howard's original proposal to the Government, and it is now being worked out at various points on the Atlantic Coast, in so far as it applies to candidates for places as watch officers. It is planned to open schools for engineer officers later in the year.

Each applicant for a place as a watch officer is informed that if he has had the proper seagoing experience he will be given a course in navigation under skilled instructors at any one of the following points which he may designate: Cambridge, Mass (Harvard College); Machias, Rockland, Boothbay Harbor or Portland, Me.; New Bedford, Mass.; Greenport, Long Island.

The teaching staff distributed at these points is under the direction of Dean Alfred E. Burton, Professor of Topographical Engineering at the Massachusetts Institute of Technology, who is a practical navigator and a former member of the Coast and Geodetic Survey. Beginning their work with class room lessons, the students are soon taken afloat on yachts or other boats provided by the Government, and are given opportunity to pursue their work under actual conditions required for finding a ship's position at sea with the use of instruments.

As soon as the students are ready for their examinations, they will be examined by representatives of the Steamboat Inspection Service, and under the rules governing the granting of papers for officers of ocean-going vessels, will be given their certificates.

First Student to Enlist, Melvin H. Fowler, of Chelsea, Mass., a Native of Cherryfield, Me.

Preliminary Service of Recruits

Unless fully qualified by seafaring experience to take a position of full responsibility at once, they will be placed for training at sea as junior officers on coastwise vessels, or those in the South American trade, and will go on pay, probably at $75 a month, for the period that they are to serve in this way. The ships to which they are assigned will carry their full complement of officers as usual, and the new juniors will stand watches with them, thus gradually working into the way of taking charge of the deck on their own account.

As the new ships come out—and the first of them will be overboard inside of six months—officers for them will be chosen in part from among the men thus trained. A man then goes on full pay for his grade at the going war rate for the transatlantic service. At present that totals, with war bonus, about $350 a month for captains, $250 a month for first officers, and in proportion for second and third mates.

It will be seen, therefore, that Uncle Sam offers a lavish inducement to men with a knowledge of seagoing to come forward and help break the power of the predatory Germans on the sea. At this writing it appears that this

power is diminishing, but the United States Government is placing no reliance on chance, and is preparing for eventualities on a scale aimed to nullify the submarine menace, however great it may grow to be. There is no doubt in the minds of men conversant with the plans of the shipping board that this can be done in the way that Uncle Sam is starting out to do it. His plan in essence is to put his cargoes in so many bottoms that only a fraction of them can be sunk by the German submarines at their best. The rest will get through, with the consequent assurance of a steady stream of supplies for the Allies and for our own gallant boys in France. That, as the Government sees the situation, means the ultimate wearing down of the Hun, for he has himself said that his reliance is the submarine. Blockaded, with his food supply limited and steadily diminishing, with his rolling stock worn out or tied up for want of lubricants, with discontent growing among his deluded subjects, who have been fed upon false reports of victories, the Kaiser will find himself spent by mere attrition of his forces.

Value of Merchant Marine Service

Therefore, says the Shipping Board, the man who steers a cargo of supplies through the submarine zone is as mighty as an army with banners. He is indeed the army, for he has the army's stomach in his keeping. Therefore the Government expects every man who feels in his heart that he can do something for his country on the sea, to drop his oar or wheel or monkey wrench and come forward, sending his name to Henry Howard, Custom House, Boston, as fast as wire or mail can carry it.

When the war is over, according to shipping experts, the United States perforce will be one of the leading shipbuilding, as well as one of the leading shipowning, nations of the world. The logic of the situation is all in that direction. For these reasons the positions which Uncle Sam now offers his sailor sons may become permanent ones. The flag will fly on the sea in the next generation as it has never flown before. Confidence of this is in the air at Washington.

In the past two months there has been much discussion in the press on what appeared to be a controversy between Shipping Board officials on the merits of wooden and steel ships for the new blockade-running fleet. Chairman William Denman, of the Shipping Board, favored the building of as many wooden ships as possible, for immediate use. General Goethals, speaking at a dinner in New York, remarked that the birds were still nesting in the trees that would go into wooden ships. He emphasized the limitations on wooden shipbuilding, through want of material, yards and labor. Others have pointed out that many of the famous New England yards had fallen into disuse when the war began. The old race of shipwrights had died. Their sons did not follow the trade of their fathers.

The Wooden Fleet

This was all true, yet it did not alter the fact that a certain number of wooden ships could be built, and several have been contracted for. While not as permanent as steel vessels, these wooden ships show a sturdy design, and one that indicates years of service. They are about 3,000 tons register and not unlike the old wooden revenue cutters, which did service on the American coasts for generations and even braved the pressure of Arctic ice without straining or leaking. A considerable number of these vessels are taking shape in the New England yards and elsewhere. The constructor in charge of the work in New England is William H. Hand, Jr., of New Bedford, a practical naval architect, who developed the now well-known V-bottom type of power boat. Mr. Hand has faith in the wooden ship as a means to an end. "When you want a club to beat off a mad dog with you are not particular what kind of a club it is, if it will do the work," says Mr. Hand privately, and in that remark lies the logic of the wooden ship.

Of steel ships the emergency fleet will be composed in the main. They will be stout, effective boats of about 8,800 tons deadweight, perfectly adapted to the work they are to do. Within six months one of them will take the water every day in the month; within a year, two.

The German ships, which are being fitted out for service by the Shipping Board, present a different angle of the programme. Many of them are passenger vessels, with no cargo capacity worth counting. These will be used as troopships, without much doubt, and though they aggregate 600,000 tons register, their acquisition does not lessen the need of speedy and effective action, such as is now going on, for the building and manning of Uncle Sam's emergency fleet.

Recruiting Battalion of Service Men

The recruiting committee of the New York Mayor's Committee on National Defense has organized the Recruiting Battalion of Service Men, to be made up of two thousand men who have worn their country's uniform in any branch of the regular service, the National Guard and the Naval Militia. These men, in squads of five to twenty, will address and give out information to numerous audiences throughout the city of New York. The recruiting committee earnestly appeals to every man who has worn the country's uniform to send to its secretary, Lewis K. Brown, 50 East Forty-second street, his name, business and home addresses, with telephone numbers, and an offer of service for one night a week on the recruiting battalion. It also requests that political, civic, fraternal, trade and social clubs, unions and orders, where members are largely of enlistment possibility, offer meetings for this purpose.

Coast Guard Cutter McCulloch Sunk in a Collision

The Coast Guard cutter *McCulloch*, one of the oldest vessels in the Coast Guard service, was sunk in collision with the passenger steamer *Governor* off Point Arguello, Cal., on June 13. The accident occurred in a dense fog and no casualties resulted. Since the beginning of the war the *McCulloch* has been patroling the California coast. During the Spanish-American war the *McCulloch* participated in the battle of Manila Bay.

Coast Survey Steamer Patterson Strikes Rock

The Coast and Geodetic Survey steamer *Patterson*, which left Seattle, Wash., on April 25, arrived at Juneau, Alaska, on May 10, and proceeded to its field of operations in Cross Sound and Icy Strait. On May 24 word was received that the steamer had struck a rock, carrying away its rudder and injuring its bottom. A later report stated that the vessel was leaking and that the rudder was injured beyond field repair. On May 28 the S. S. *Explorer* was directed by wire to go to its assistance from Ketchikan. Repairs will be made at Juneau if practicable, in order that the vessel may resume field work promptly.

Standard Wooden Steamships for United States Shipping Board Emergency Fleet

Plans and Specifications of Standard Type, 3,500-Ton Wooden Cargo Steamer Designed by Theodore E. Ferris, Naval Architect of United States Shipping Board

SUPPLEMENTING the brief description of the standard type wooden cargo steamers for the United States emergency fleet given in our June issue, we print herewith complete plans and more extended extracts from the specifications of these vessels. These plans have been worked out by Theodore E. Ferris, naval architect, 30 Church street, New York, who has been appointed official naval architect for the Shipping Board.

The principal dimensions of the ships are as follows:

Length overall.....281 feet 6 inches
Length between perpendiculars.....268 feet
Beam, over planking.....46 feet
Depth, molded at side of upper deck.....26 feet
Load draft from bottom of keel shoe.....23 feet 6 inches
Total estimated deadweight.....3,500 long tons
Sea speed, loaded.....10 knots
Indicated horsepower.....1,400

The estimated weights of the standard wooden ships as furnished by the naval architect are as follows:

ESTIMATED WEIGHTS

Item	Yellow Pine Ship Long Tons	Douglas Fir Ship Long Tons
Wood in hull	1,677.0	1,827.0
Fastenings	142.4	145.7
Anchors and cables	31.4	31.4
Paint and calking	10.0	10.0
Forgings and castings	35.0	35.0
Hull piping and machinery	50.0	50.0
Two guns	7.0	7.0
Miscellaneous outfit	27.2	27.9
Total hull weight	1,980.0	2,134.0
Propelling machinery	275.0	275.0
Deadweight	3,625.0	3,421.0
Displacement at 23′ 6″ S. W.	5,880.0	5,830.0

These figures for the wood hull are based on bills of material after deducting scrap, and for lumber of about 18 percent moisture. Green lumber well weigh about 12 percent more.

General Arrangement

The vessel is of the single deck type with hold beams and shifting 'tween decks with wood deck houses on the bridge and poop decks. The vessel has a straight stem and elliptical stern and is fitted with two wood pole masts, fitted with cargo booms, and one smokestack. Four cargo hatches are provided in the upper deck and a small hatch in the poop deck.

Four calked watertight wooden bulkheads extend to the upper deck, forming two cargo holds and the machinery space. There is a deep tank forward of amidships for water ballast and also water tanks for boiler feed. Culinary water will be carried in separate steel tanks located in the engine room. The after peak is piped for fresh water for boiler feed and for salt water for the trimming tank. The fore peak is piped for fresh water only. Steam winches are fitted at the hatches for working the cargo booms.

The amidship deckhouses on the bridge deck contain the officers' quarters, chart room, wireless, gunners, quarters for petty officers, engineers, cooks, oilers, messmen, etc. The bridge space is used for coal or cargo and a part of the poop space for stores or cargo. Awnings will be fitted over the bridge abreast the wheel house, over the boat deck between the officers' house and wireless house, abreast of the officers' house, abreast of the steering house, and around the stern at the poop deck.

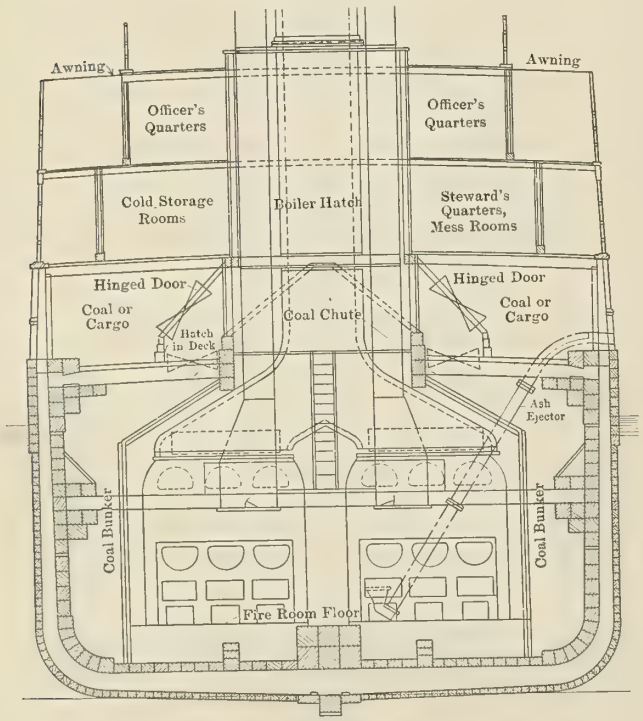


Fig. 1.—Section Through Boiler Room, Looking Aft

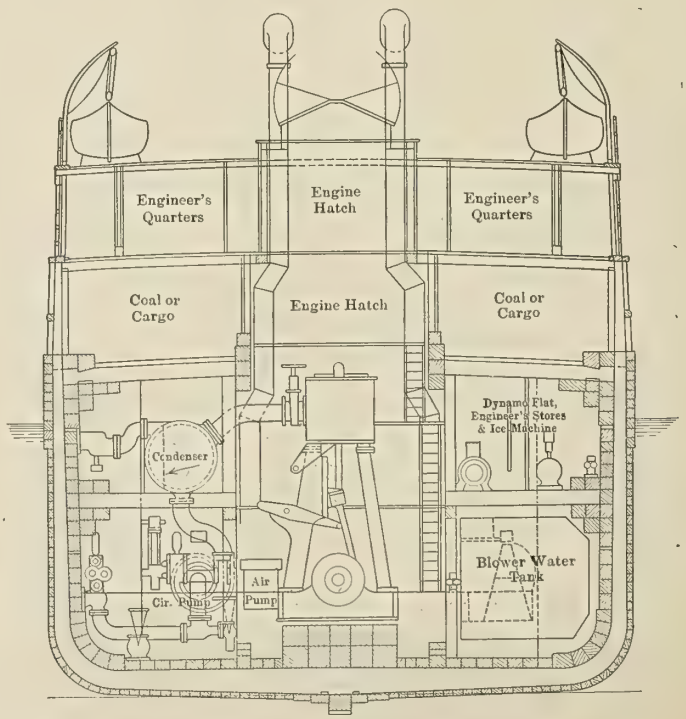
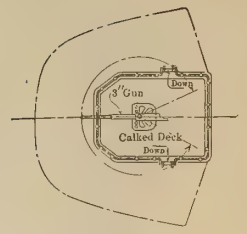


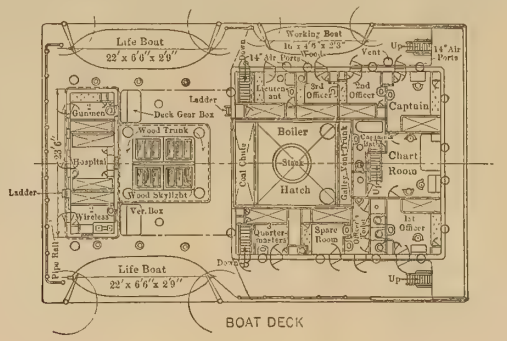
Fig. 2.—Section Through Engine Room, Looking Forward

STANDARD TYPE, 3,500-TON WOODEN CARGO STEAMSHIP

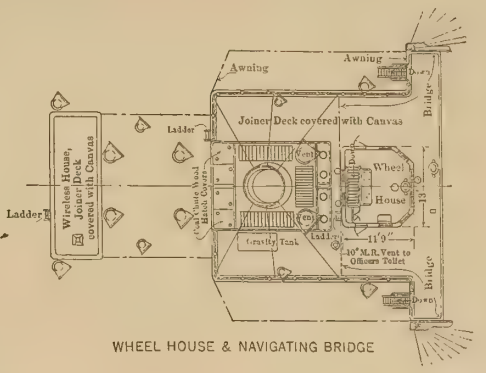
Designed by Theodore E. Ferris, Naval Architect, New York, for the United States Shipping Board



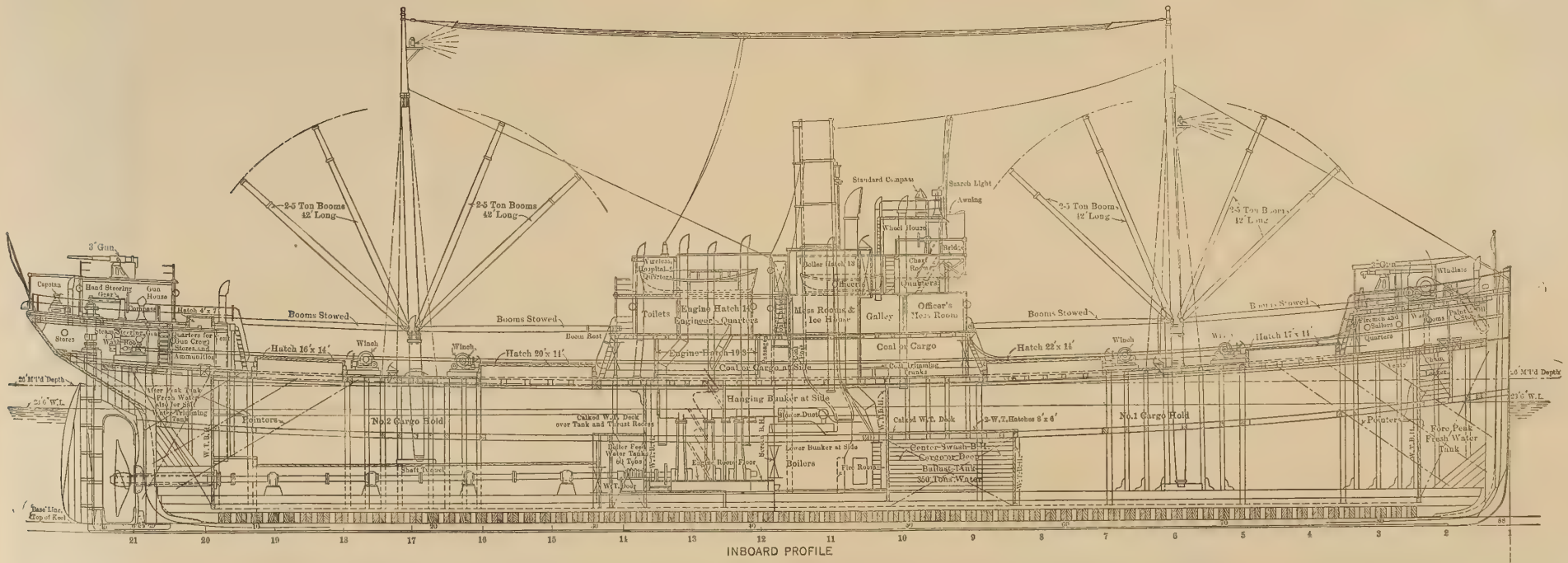
TOP OF GUN HOUSE



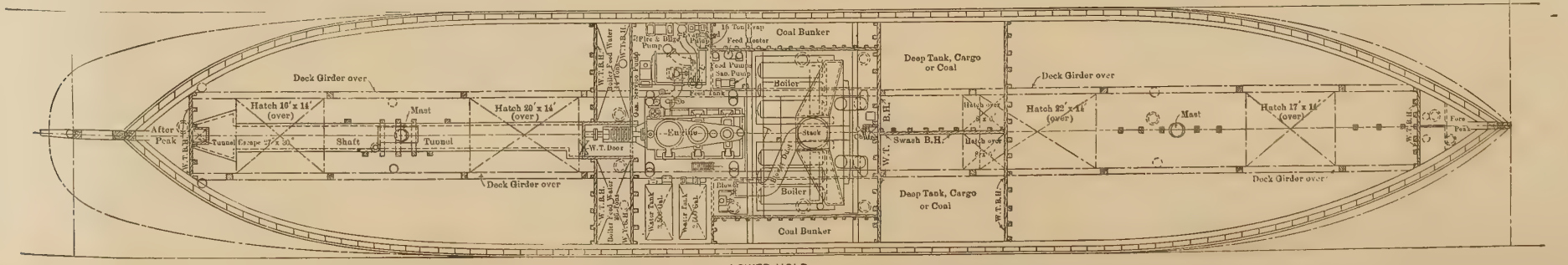
BOAT DECK



WHEEL HOUSE & NAVIGATING BRIDGE



INBOARD PROFILE



LOWER HOLD

Fig. 3.—Inboard Profile and Plans of Lower Hold and Boat and Bridge Decks

Su

STANDARD TYPE, 3,500-TON WOODEN CARGO STEAMSHIP

Designed by Theodore E. Ferris, Naval Architect, New York, for the United States Shipping Board

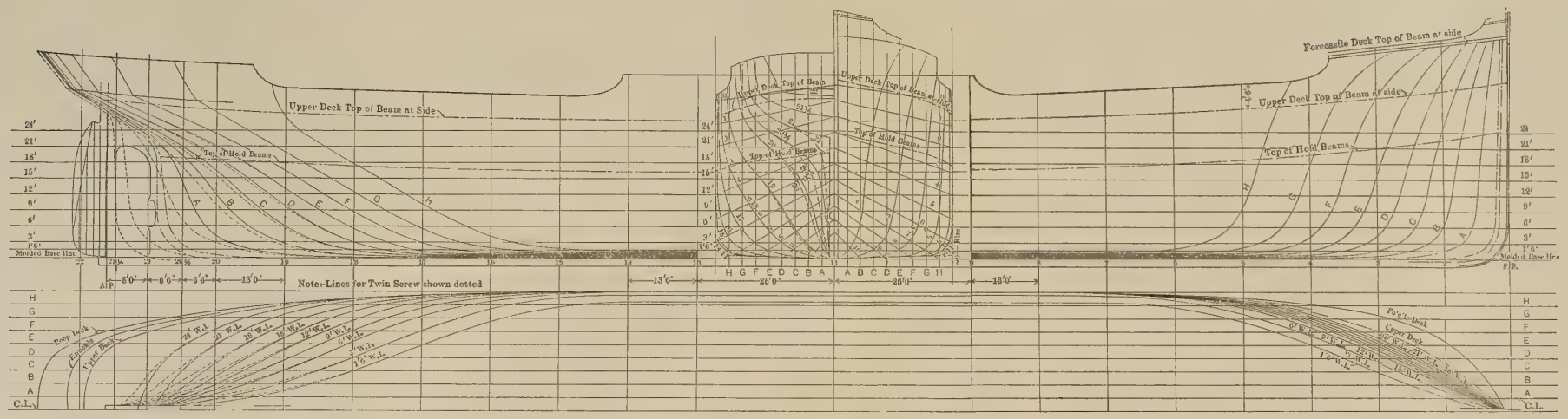


Fig. 4.—Molded Lines of Wooden Cargo Steamer

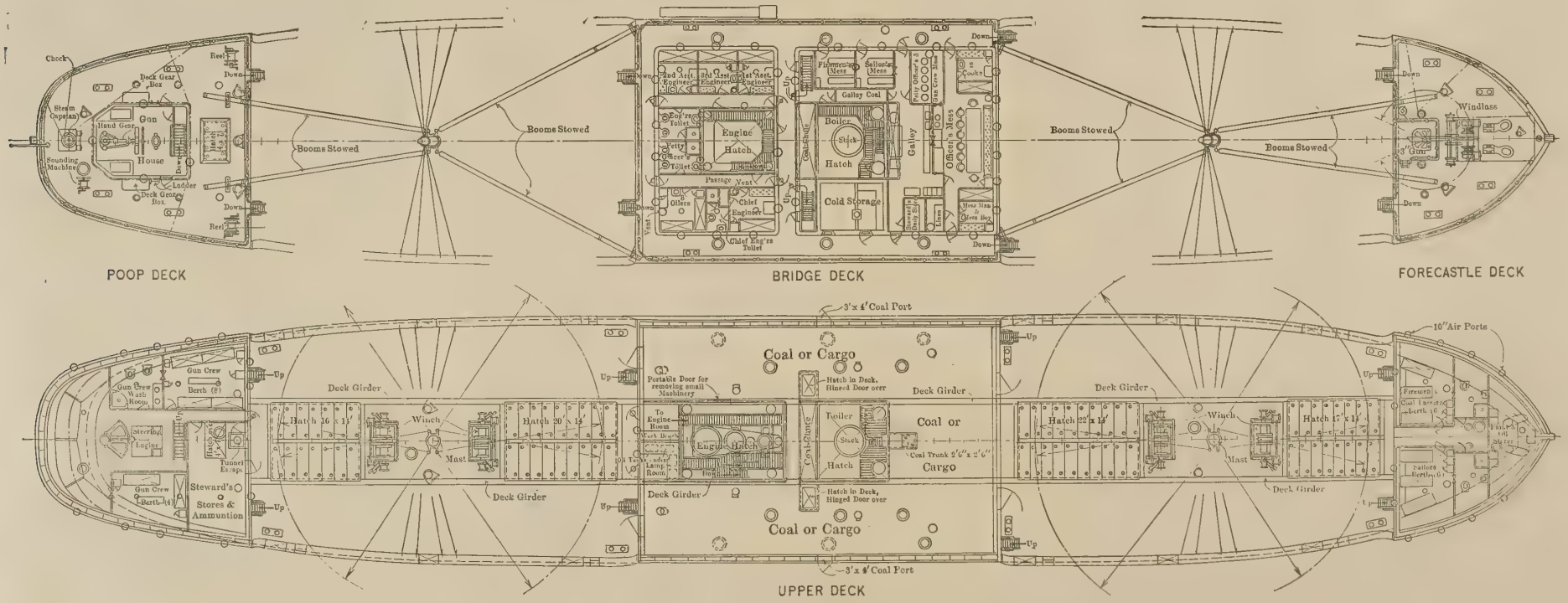


Fig. 5.—Deck Plans of Standard Wooden Cargo Steamer

STANDARD TYPE WOODEN CARGO STEAMSHIP

Designed by Theodore E. Ferris, Naval Architect, New York

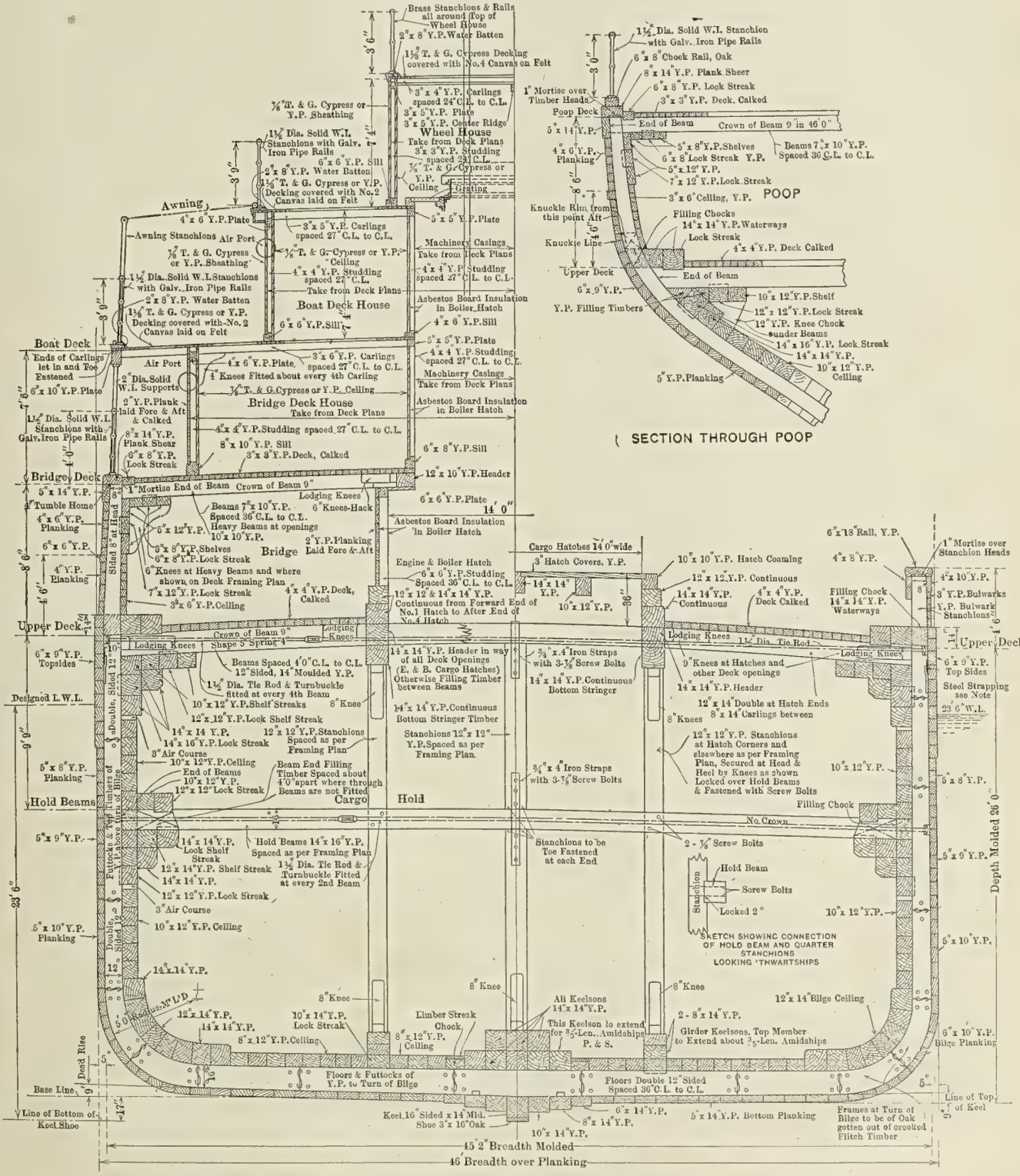


Fig. 6.—Midship Section, Showing Scantlings

PROPULSION

The propelling machinery will consist of one triple expansion engine; two single-ended Scotch boilers or water-tube boilers fitted with heated forced draft for coal burning with one fire room, together with all necessary auxiliaries, electric light plant, steam winches, warping capstan, steam windlass, steam and auxiliary hand-steering gear, ice machine, steam heating system and complete drainage system. Twin screw reciprocating or geared turbine steam propelling machinery may be substituted for the single screw propelling machinery, subject to approval of the owners.

MATERIALS

The timber and lumber used in the construction of this vessel may be either dense southern yellow pine as graded by the Southern Pine Association, or Douglas fir. Specifications for both materials are given, although the following applies to yellow pine, the scantlings for which are shown on the midship section, Fig. 6.

The entire hull will be of yellow pine except the stern post, rudder post, rudder stock, horn timber, shaft log and keel shoe, which will be of white oak. Wood knees will be of hackmatack or oak. Treenails will be of locust or split oak. Joiner sheathing and decks, where specified, will be of cypress.

HULL CONSTRUCTION

The keel is of yellow pine 16 inches by 14 inches, to which is fitted a shoe of white oak 3 inches thick and 16 inches wide.

The stem of yellow pine is sided 16 inches and molded 20 inches. The apron of yellow pine is 16 inches by 16 inches backed up with a second apron of the same size. Both aprons are in one length, extending to the forecastle deck. The stem grip is of white oak sided the same as the stem. The knight heads are of yellow pine sided 20 inches and molded the same as the frames, fayed up to inside the apron. The forward deadwood and knee are of yellow pine sided 16 inches and molded 18 inches, extending from through the floors forward for receiving the heels of the cant frames. The knee is of hackmatack or oak, connecting the keel to the stem grip, and apron 16 inches sided with long arms. The forward deadwoods are of yellow pine sided 16 inches, bedded in between the top keelson and apron.

The outside and inside stern posts are of white oak sided 28 inches in way of the shaft log 16 inches above the keel and at head molded 24 inches. The lower end of each post is tapered to the siding of the keel and to have a tenon 5 by 12 by 14 inches fastened with two 1⅜-inch treenails. Each stern post extends to the upper deck and is fastened to the deck beams. The after side of the outer post is rounded out above and below the stern bush casting for an easy flow of the water.

The shaft log is of white oak built up in four pieces 14 by 14 inches bored out to receive the stern tube. The after deadwood and knee are of yellow pine sided 16 inches and molded 18 inches, extending from through the frame floor aft to the stern post for receiving the heels of the cant frames. The after deadwoods are of yellow pine sided 16 inches, bedded in between the top of the shaft log and inner stern post.

The rudder post is of white oak sided 16 inches, molded 18 inches, to have a tenon in the keel 5 by 12 by 14 inches fastened with two 1⅜-inch treenails.

FRAMING

The rudder stock is of selected best white oak finished 18 inches in diameter. The rudder blade is built up of yellow pine tapered to 14 inches at the after edge.

The main frames are double-sawed of yellow pine. The bilge frames are worked out of crooked oak, straight fir or wide yellow pine, sided 12 inches, molded on keel 18 inches, at turn of bilge 16 inches, at top of bilge 12 inches, at upper deck 10 inches, at bridge, forecastle and poop deck, 8 inches; also at bulwark rail, 8 inches. The frames are spaced 36 inches center to center. In way of the bridge, forecastle and poop, the frames continue up double.

There are eight main keelsons of yellow pine 14 by 14 inches, and on each side girder keelsons of yellow pine arranged as shown on the midship section, the first strake 10 by 14 inches, and the second and third strakes 8 by 14 inches. The first and second strakes are worked the full length between the peak bulkheads, the third or top strake is worked for about three-fifths the length amidships.

CEILING AND PLANKING

The bottom and side ceiling is all of yellow pine. The bottom ceiling is 8 by 12 inches, the side ceiling 10 by 12 inches. One strake of the side ceiling on each side is 12 by 12 inches locked over the frames, as shown on the midship section. There are three strakes of bilge ceiling on each side of yellow pine, 14 by 14 inches, with five strakes between 12 by 14 inches. The garboard strakes are of yellow pine; the first strake, 10 by 14 inches; the second strake, 8 by 14 inches; third strake, 6 by 14 inches.

The outside planking, also of yellow pine, is as follows: Bottom planking, 5 by 14 inches; bilge planking, 6 by 10 inches; side planking, 5 by 10 inches, 5 by 9 inches, 5 by 8 inches; topside planking, 6 by 9 inches. Between the planking and the frames is a system of iron strapping arranged as follows: At the upper deck beams is a top chord, 8 inches by ¾ inch, extending from 12 feet forward of the forward hatch to 12 feet aft of the after hatch. The plates in this chord are connected by triple riveted butt straps and are fastened to each frame by two 1-inch by 10-inch bolts, staggered. Diagonal straps of 4-inch by ½-inch iron, let into the outside of the frames, and inclined at 45 degrees each way, are fitted so as to meet at the top chord in every frame space. The diagonals are connected to the chord by two ⅞-inch rivets at each crossing by one 1-inch rivet. They are also fastened to each frame timber by one 1-inch by 10-inch bolt. The diagonals are to be carried well down and wrapped around the bilge far enough to overlap the ends of the floor timbers.

DECKS

At the upper deck are two strakes of deck beam shelf timbers on each side, 10 inches by 12 inches, one lock strake, 12 by 12 inches locked 2 inches over the beams, and one bosom strake, 14 by 14 inches. The hold beam shelf timbers consist of one strake, 10 inches by 12 inches on each side, and one lock strake 12 inches by 12 inches, while below the hold beams is one strake 12 by 14 inches, one lock strake 14 by 14 inches and one bosom strake 14 by 14 inches.

The upper deck beams are of yellow pine, sided 12 inches, molded 14 inches, worked with 9-inch crown shape 5 inches and spring, 4 inches. The beams are doubled at the hatch and engine and boiler openings. The beams are spaced about 4 feet center to center. In way of hatches and other openings carlin beams are fitted, sided 8 inches, molded 14 inches.

The hold beams are of yellow pine, sided 14 inches and molded 16 inches. They are fitted throughout the hull between hatches and other upper deck openings, spaced about 4 feet centers. Beam and filling timbers, spaced about 4 feet apart, are fitted between the upper and lower shelf timbers where through-hold beams are not fitted.

Stanchions

In way of hatch coamings there are fitted on each side continuous from the forecastle-head bulkhead to the poop bulkhead deck girders made up of two 14- by 14-inch and one 12- by 12-inch timbers, with 14- by 14-inch hatch header and filling timber between through beams. The hatch-end coamings are made up with 14- by 14-inch and 12- by 12-inch toe fitted into the girder timbers, forming the remainder of the hatch coamings, 10 by 10 inches.

Center and wing stanchions of yellow pine, 12 by 12 inches, are spaced and located as shown on the framing plans. The center stanchions are connected to the keelsons with 8-inch wood knees, one stanchion in way of each hold beam, connected at the hold beam with two ¾- by 4-inch iron straps fastened with six ⅞-inch screw bolts; also connected to upper deck beams in a similar manner.

Iron tie rods, 1½ inches diameter with turnbuckles, are fitted in way of the upper beams and hold beams, spaced about every fourth beam.

Bulkheads

Forward of the boiler room bulkhead extending into the hold is a deep water tank for water ballast, extending up to the line of the hold beams. The bulkhead is of 3- by 8-inch double diagonal yellow pine, with studding of 8- by 12-inch yellow pine spaced 24 inches apart. The center fore-and-aft bulkhead is of yellow pine 6 inches thick with 8- by 12-inch yellow pine studding, spaced about 30 inches apart. These tanks will have a capacity of about 350 tons of salt water. Aft of the engine room bulkhead on each side of the thrust recess, extending up to the line of the hold beams, are tanks for boiler feed having a capacity of about 80 tons of fresh water. The tanks are constructed in the same manner as the deep water tanks. The forepeak tank is arranged for carrying fresh water. The after peak is arranged for carrying fresh water for boiler feed and for salt water for trimming purposes.

Between the engine and fire room is a steel screen bulkhead built of plating 3/16-inch thick, stiffened with 2½- by 2½- by ¼-inch angles, spaced about 24 inches apart. The bulkhead is to fit partly around the boilers and to have a hinged door for passage from the engine to fire room.

Fastenings

In the matter of fastenings, the following is provided in the specifications: All fastenings to be equal to the requirements of the American Bureau of Shipping and, in addition, in accordance with the following plans of fastenings: All nail, spike and bolt iron fastenings to be galvanized and all clinch rings galvanized. Screw bolt fastening to be used where necessary. All bolt iron fastenings through yellow pine or fir wood for bolts up to 24 inches in length to be driven with about ⅛-inch drift. For bolts exceeding 24 inches in length driven with drift of 1/16 inch; for bolts through oak, 1/16-inch drift. All bolts driven over clinch rings to be well headed and blunt or drift bolts pointed where necessary. All bolt fastenings in outside planking, waterways, plankshears, rails and weather bulkheads, and all bolt or spike fastenings in weather deck to be plugged with white or yellow pine plugs dipped in white lead paint. The treenails to be of good grade split locust, oak or other approved wood and wedged on both ends across the grain of the wood through which they are driven. As many treenails as possible, at least one-half, driven through and wedged on both ends. Tie rods and screw bolts where necessary set up in large, heavy plate washers.

Boilers

Steam will be furnished at 190 pounds per square inch working pressure by two three-furnace, marine type, coal-burning boilers, constructed in accordance with the United States Steamboat Inspection Rules and those of the American Bureau of Shipping. Each boiler will be 14 feet 6 inches inside diameter and 11 feet 2 inches long overall. The total effective boiler heating surface will be 4,500 square feet, and the total grate area 105 square feet.

Each boiler will have three independent combustion chambers. The tubes will be 2½-inch outside diameter of charcoal iron lap-welded. Each boiler will be fitted with three corrugated furnaces of the Morison suspension type of 42 inches inside diameter.

The boilers will be located in a single stokehold with a common fireroom, and the products of combustion will be led up a single stack reaching to a height of about 76 feet above the base line.

As an alternative for Scotch boilers, the following watertube boilers will be acceptable: Babcock & Wilcox, Howden, Yarrow or Mosher, with a heating surface of not less than 5,000 square feet. Other types of watertube boilers will be considered, the heating surface to be as approved.

Propelling Machinery, Single Screw Ship

For a single screw ship, fitted with a reciprocating engine, the main engine will be of the triple expansion type with cylinders 19 by 32¼ by 54 inches diameter, with a common stroke of 42 inches. The engine will be built for a piston speed of about 630 feet per minute and capable of developing 90 revolutions per minute with the ship at the load draft. The engine is designed to develop 1,400 indicated horsepower when working under full boiler pressure, with no live steam passing the high pressure cylinder and no live steam in the receivers.

Engines of a size different from the above will be accepted if capable of meeting the desired conditions, as regards indicated horsepower and piston speed.

The framing of the main engine consists of cast iron housings, while the bed plate is of cast iron. The main valves for the high pressure and intermediate pressure cylinders are of the piston type with a double-ported slide valve for the low pressure cylinder. The valve gear will be of the Stephenson link motion with double bar links.

There will be worked off the main engine, by beams, attached pumps consisting of a main air pump and two bilge pumps. The operating platform will be on the starboard side at the engine room floor.

The crank shaft is in two sections of the built-up type, secured by solid forged steel couplings and straight coupling bolts. The piston rods, connecting rods, shafting and working parts generally are forged of open-hearth steel. The crank shaft is 11¼ inches diameter. The line shafting is 10⅝-inch diameter and the thrust shaft 11¼ inches diameter, while the propeller shaft is 12 inches diameter.

The propeller is of cast iron, four-bladed.

Steam from the main engine is exhausted into a single condenser, containing about 2,500 square feet of condensing surface. Cooling water is supplied by one main circulating pump of the centrifugal type with 12-inch suction and discharge and a capacity of 2,000 gallons per minute against a head of 15 feet. The engine for driving the circulating pump is of the vertical type. The main air pump of the Edwards type works off the low pressure crosshead of the main engine. The pump is 22 inches diameter by 18 inches stroke. Two bilge pumps of 3½ inches diameter by 18 inches stroke are also worked off the low pressure crosshead of the main engine.

Independent Pumps

Two main and auxiliary feed, 10 by 6 by 12 inches, vertical simplex type. One general service, 10 by 6 by 10 inches, horizontal duplex. One fire, bilge and general service, 10 by 6 by 10 inches, horizontal duplex. One sanitary, 6 by 5¾ by 6 inches, horizontal duplex. One fresh water, 4½ by 2¾ by 4 inches, horizontal duplex. One evaporator feed, 4½ by 2¾ by 4 inches, horizontal duplex.

Auxiliaries

Located in the engine room is a forced draft fan driven by a direct-connected engine for supplying air for a system of heated forced draft. The fan is capable of handling continuously air for the combustion of 3,000 pounds of coal per hour at a pressure of 2 inches of water at the blower outlet. The fan is driven by a single fully inclosed dust- and moisture-proof vertical inverted cylinder high-speed steam engine.

In the fire room is a 6-inch hydraulic ash ejector operated by water from the fire and bilge and general service pumps.

Located in the engine room is a feed water heater of sufficient capacity to heat 30,000 pounds of feed water per hour from 120 to 212 degrees Fahrenheit when using exhaust steam at 5 pounds per square inch gage. The rise in pressure of the feed water passing through the tubes shall not exceed 20 pounds per square inch.

There is also a feed and filter tank of 800 gallons capacity installed in the engine room.

Propelling Machinery, Twin Screw Vessels

In the twin screw vessels propelled by reciprocating engines, the boiler plant will be identical with that for the single screw vessels. The engines themselves will be of the triple expansion type with cylinders 14¾ by 25 by 42 inches diameter with a common stroke of 27 inches. The engines will turn outboard when going ahead.

The engines will be built for a piston speed of about 600 feet per minute and each engine will be capable of developing 900 indicated horsepower at 133 revolutions per minute. when working under full boiler pressure with live steam in the receivers, and 700 indicated horsepower at 115 revolutions per minute, with no live steam in the receivers. Engines of different size from the above will be accepted if they are capable of meeting the desired conditions of indicated horsepower and piston speed.

The framing of the main engine consists of cast iron back housings and cast iron or forged steel front columns. The bed plate is of cast iron. The main valves for the high pressure and intermediate cylinders are of the piston type with a slide valve for the low pressure cylinder. The valve gear is of the Stephenson link motion with double bar links.

The operating platform of each engine will be on the inboard side at the engine room floor with reversing gear, throttles and stop valve gears, cylinder drains, receiver valve gears, etc., all collected at one point.

The crank and thrust shafts are 8 inches in diameter, while the line shafting is 7½ inches diameter. The propeller shaft is 8½ inches diameter. The propellers are solid, three-bladed of cast iron.

Engine Room Auxiliaries

Two main condensers are provided, each with a condensing surface of 1,300 square feet. There are two main circulating pumps of the centrifugal type with 8-inch suction and discharge, each pump being driven by a vertical engine. The main air pumps are of twin beam type, 7½ by 17½ by 10 inches.

The independent pumps include the following:

Two main and auxiliary feed, 10 by 6 by 12 inches, vertical simplex. One general service, 10 by 6 by 10 inches, horizontal duplex. One fire, bilge and general service, 10 by 6 by 10 inches, horizontal duplex. One sanitary, 6 by 5¾ by 6 inches, horizontal duplex. One fresh water, 4½ by 2¾ by 4 inches, horizontal duplex. One evaporator feed, 4½ by 2¾ by 4 inches, horizontal duplex.

A feed water heater and feed and filter tanks and other auxiliaries are provided, similar to the equipment for the single screw ships.

Propelling Machinery, Single Screw Geared Turbines

For a single screw, geared turbine, coal-burning ship, the propelling machinery is to be built to conform with and meet the requirements of the American Bureau of Shipping and the rules and inspection prescribed by the United States supervising inspectors of steam vessels.

The turbine is to be of the General Electric, Westinghouse, De Laval, Kerr or other approved make of 1,400 shaft horsepower and connected to the main shaft by double helical gearing. The revolutions of the main shaft are not to exceed 110 per minute. A backing turbine will be incorporated in the same casing with the ahead turbine, and, when supplied with the same amount of steam as used for full load conditions, will develop not less than two-thirds of the full power ahead torque on not more than two-thirds of the full speed revolutions per minute.

With steam at 180 pounds gage pressure at the throttle and 28 inches vacuum in the condenser, and at normal full power revolutions, the steam consumption will not exceed 12.5 pounds per shaft horsepower per hour.

The thrust bearing will be of the Kingsbury type, incorporated in the low speed gear and casing. The propeller is of cast iron, solid, four-bladed.

The engine and fire room auxiliaries are the same as in the single screw ship driven with reciprocating engines with the exception of the main air pump, which will be of the twin-beam type, 12 to 28 inches by 18 inches. There will also be an auxiliary combined air and circulating pump, 10 by 12 by 12 inches, horizontal duplex.

Form of Contract

Contracts for the construction of the standard type wooden vessel, it is understood, will be let on a lump-sum basis only. According to the terms of the contract, for an order for twelve ships the Shipping Board agrees to pay a certain sum within thirty days after signing the contract; 5 percent of the contract price of all twelve ships within sixty days after signing the contract; 5 percent of the contract price of all twelve ships within ninety days after signing the contract.

When the keel of each ship is laid there will be paid 20 percent of the price of the ship. When each such ship is completely framed, 30 percent of the price of the ship will be paid. When each such ship is launched, 15 percent of the price of the ship will be paid. When the machinery in each ship is installed, 10 percent of the price of the ship will be paid and the balance on each ship will be paid thirty days after delivery to and acceptance thereof by the owner.

Before final acceptance of the ship, the owner may make at the contractor's expense a dock trial of not exceeding six hours, or a sea trial at some point convenient to the contractor's yard of not exceeding four hours.

Inspectors appointed by the owner will inspect all materials and workmanship entering into the construction of the ships, and these inspectors are authorized to reject all materials and all workmanship which do not comply with the specifications agreed to.

The owner reserves the right by orders in writing to make such reasonable alterations, improvements, additions or substitutions not materially affecting the general design of the vessel as the owner may deem necessary. Such alterations or changes will be compensated for by the owner.

Corrosion of Condenser Tubes*

It is common knowledge that the committee originally appointed by the Institute of Metals to investigate the corrosion of condenser tubes has been reconstituted, and now includes representatives of the Admiralty and the Board of Trade, as well as members appointed by some other societies and corporations specially interested in this matter. The earlier researches were conducted at Liverpool by Mr. (now Captain) G. D. Bengough, in such intervals as his normal work at the university permitted. On the reconstitution of the committee, however, substantial financial aid was promised from national sources, on condition that the work should be pushed forward under the direction of a "whole-time" investigator, a post which was naturally offered to Captain Bengough. The research is now being conducted under ordinary working conditions at the Corporation Electricity Works, Brighton, while the laboratory investigations are being carried out at the Royal School of Mines under the immediate direction of Captain Bengough. At Brighton a set of eight small condensers, each containing 12 tubes, 3 feet long, are being run in parallel, both with each other and with one of the main condensers at the power station. The cooling water is obtained from the sea, the station being situated on the inlet at Shoreham. The tubes in the several small condensers are in each case of a different material, and, for the purposes of comparison, 16 of the tubes in a main condenser of the power station have been replaced by special tubes of four different alloys.

A special interest attaches to the installation because the power station condensers have been fitted with the Cumberland system of tube protection, which is effected by maintaining an electric current between the tubes and the electrolyte in such a direction as to inhibit corrosion. No tubes or materials are tested at Brighton until preliminary tests in the laboratory have given promise of results justifying the additional expense. The work so far accomplished has shown that corrosion may be started by defects in the tube arising in the course of manufacture. In the case of brass tubes the presence of a "spill" inevitably leads to erosion. This "spill" originates in a blowhole against the sand core of the casting from which the tube is made. In the process of drawing this hole is deformed into a long groove, which is covered with a tongue or sliver of metal. Air collects in the space underneath this "spill," and whenever air collects on a brass tube immersed in sea water corrosion appears to be inevitable. Each tube is very carefully examined for internal flaws before being tested at Brighton, and the position of each is carefully recorded. Not all surface defects, even in brass tubes, appear to give trouble. An open groove, free from the long covering "spill," appears to matter little. The "swarf" holes are an example of this. These are produced by a neglect to completely clear the tube blank from every bit of swarf after boring and before drawing. The pits produced by these particles of swarf appear to matter little.

A point now being investigated is whether the presence of oxide in the tube is deleterious. To this end a number of oxide-free brasses have been prepared from cathode copper and Brunner-Mond zinc, melted in an atmosphere of hydrogen. The molten metal was not cast, but allowed to set in the crucible, which was cooled from below, so that the gases occluded on solidifying should not be entrapped. The whole of this operation was conducted in an atmosphere of hydrogen, and the tubes have been prepared from this oxide-free metal by the Broughton Copper Company. These tubes are now under test, but as yet it is uncertain whether they will show any superiority.

Among the tubes being tested are those containing 2 percent of lead, introduced by the Muntz Metal Company some few years ago. Since the lead does not form a solid solution with the rest of the alloy, but separates out in small spicules, it might have been anticipated that the presence of this free metal would give rise to local electrolytic effects and consequent corrosion. It appears, however, that this does not occur; the lead forms an adherent basic salt, which spreads over the surface and appears to protect it from further action. Another metal under test is an alloy of 10 percent of nickel with 90 percent of copper. So far this has proved quite immune to attacks in the laboratory, although the tubes furnished have had such rough interiors that when placed in a sea-water bath they immediately cover themselves with air bubbles. When similar bubbles collect on brass a white oxychloride of zinc is deposited, which acts as a catalytic agent, taking up chlorine from the sea water and passing it on to the zinc, with the result that the metal is dezincified. The resistance of the 10 percent nickel alloy is the more notable in that failures are reported to have occurred with tubes made from a 20 percent nickel alloy and from a 2 percent nickel alloy. Another interesting alloy under observation is one of copper with 7.8 percent aluminium. Preliminary tests with this have proved promising, and it is hoped to get still better results with oxide-free metal. The specimens so far tested have not been free from oxide, and have been found liable to a very curious attack consisting of small pinholes, which deepen rapidly. Elsewhere there appears to be no corrosion at all.

An American report having stated that the resistance to corrosion is improved by annealing the metal at a temperature just high enough (about 400 degrees C.) to secure recrystallization, the point is being thoroughly investigated, the annealing being effected in an electric furnace which can maintain indefinitely four tubes, each 4 feet long, at the desired temperature within a range of some 4 degrees C. Other tubes are being annealed at a temperature of 600 degrees C. before the test. This temperature destroys the effect of cold-working, which is commonly supposed to favor corrosion.

In the experimental condensers at Brighton the temperature on the steam side of the tubes differs much from point to point. The middle of the tubes, immediately under the steam inlet, is kept clear of air by the inrush of the steam, and the tube is consequently hot here. At the end of the condenser, the steam being more stagnant, air collects round the tubes, materially lowering the temperature. Again, the tubes at the bottom are colder than those at the top. It has been observed that the local temperature of the tube appears to have a marked effect both on its liability to corrosion and on the kind of corrosion set up.

The investigation is undoubtedly one not merely of national but of international importance, since the cost of replacing condenser tubes aggregates annually to an extremely large figure. It is to be hoped that the research will be pushed to a successful conclusion as rapidly as the conditions permit. Since, however, accelerated tests are considered unreliable, the investigation must necessarily require some years for its completion, but interim reports of high value will undoubtedly be issued from time to time.

* From *Engineering*.

Reinforced Concrete for Shipbuilding

Discussion of Application of Reinforced Concrete to Ship Construction—Design for Reinforced Concrete Barge and Freight Steamer

BY ALLEN HOAR, C. E.

THE shipping industry is to-day facing one of the most serious problems with which it has ever been confronted. The daily destruction of tonnage, figuring into several thousands, forces us to meet an overwhelming shortage in cargo bottoms. The immediate effect of this upon commerce and industry—the merchant, the manufacturer, the producer, the consumer—is at once apparent. It is bound to upset the whole economic balance of the entire world. At the cessation of the present hostilities in Europe the greatest activity in shipbuilding ever known must be looked forward to. Ships lost must be replaced and the number increased to take care of the enormous amount of shipping incidental and necessary to the period of reconstruction throughout Europe.

Drain on Steel and Lumber Resources

But how is this to be accomplished—what about the present status of the steel and lumber industries? At the present time, with the shipbuilding activity of this country just awakening, the cost of these materials is almost prohibitive. Furthermore, the vast drain created by this activity on the developed resources of the country is sorely affecting other industries, the chief consumers of steel and wood under normal conditions, and ultimately the public, who must pay for the increased high cost of goods.

The only practicable solution of this problem, then, seems to be in finding some other suitable material for this purpose—one which is a relatively cheap commodity, the raw supply of which is obtained in great abundance, widely distributed throughout the entire country and nearby our sea coasts. The only building material which has these qualifications, together with the necessary physical requirements, is reinforced concrete. This material presents itself as the logical one to replace steel and wood in the construction of ships, not merely as a substitute for steel or wood, but as a material superior to either of these from the standpoint of general adaptability, first cost and cost of maintenance.

Concrete Ships No Novelty

Concrete as a material for ship construction is not new, although today its general use for this purpose is looked upon with the same degree of skepticism that steel was but a very few years ago. The employment of reinforced concrete in the construction of vessels may be truthfully said to date back to the time of the early Egyptians. In Egypt boats were built of clay and reed, and used on the Nile several hundred years ago. These boats were built of a natural clay or cement plastered over a framework of reeds for reinforcement. The principles of construction used were practically the same as those used on many types of vessels that have lately been built, except that now steel is used instead of reed and Portland cement concrete instead of natural cement.

Since this time many experiments have been made and much progress accomplished in the use of reinforced concrete for the construction of floating bodies. In the last few years particularly, there have been many and various types of reinforced concrete vessels constructed. These have included floating caissons for foundation work, pontoons for various purposes, floating drydocks, pleasure craft, lighters, cargo vessels—both towed and self-propelled vessels—and car ferries. Although up to the present time no large ocean-going steamships have been constructed of this material, freight lighters having a full-load displacement of three thousand tons or more have been built, and this is but indicative of what can be done and a substantial evidence of the practicability of reinforced concrete for use in shipbuilding.

Concrete materials are found ready to hand in practically all markets. Cement is manufactured, or can be manufactured, nearby almost every available location suitable for shipbuilding. The raw materials for cement are widely distributed over the entire country and the supply is almost without limit. The proximity of cement mills to the sea coast eliminates the factor of disproportionate freight rates. Reinforcing steel can be rolled by small local mills, and, therefore, the user of it is not made subservient to the convenience of the large steel corporation in the manner in which the builder is who must use large plate and heavy rolled structural shapes. Sand and gravel can oftentimes be found at the site of construction. In fact, all the materials for a concrete ship can be found within the radius of a very few miles, and the vessel built practically at the launching point.

Physical Properties of Reinforced Concrete

Next for consideration are the physical properties of reinforced concrete. The various classes of structures and uses in which reinforced concrete has been employed, and its behavior under stress, are too well known to need any lengthy discussion here. Theoretical studies and practical experiments have now produced rational and positive methods for computing the strength of reinforced concrete so that absolute dependence can be placed upon it. Reinforced concrete has safely withstood forces of sudden impact caused by failure of or accident to some adjacent member or mechanism. It has proved itself superior to any other building material in resisting severe earthquake shocks and like disturbances in many parts of the world. It is a material in which its internal resisting qualities can be so utilized and distributed to the most advantage—the steel where it is most efficient in taking up the tension, and the concrete where it will best react against compression. To properly and economically take care of the excessive strains to be encountered in ship work requires just such a material as this.

The plastic nature of concrete is ideally suited to the formation of shapes and curvatures so difficult and costly to make with either steel or wood. Reinforced concrete instantly adapts itself to the construction of any desired shape—it is essentially a material to be molded, and a ship is essentially a structure to be molded. The monolithic character of reinforced concrete construction affords at the same time, the greatest amount of strength and rigidity with the maximum amount of elasticity.

The ability of reinforced concrete to withstand the extreme stresses to which a ship rolling in a heavy sea is subjected, supported first almost entirely on two waves, one at the bow and the other at the stern, and then riding

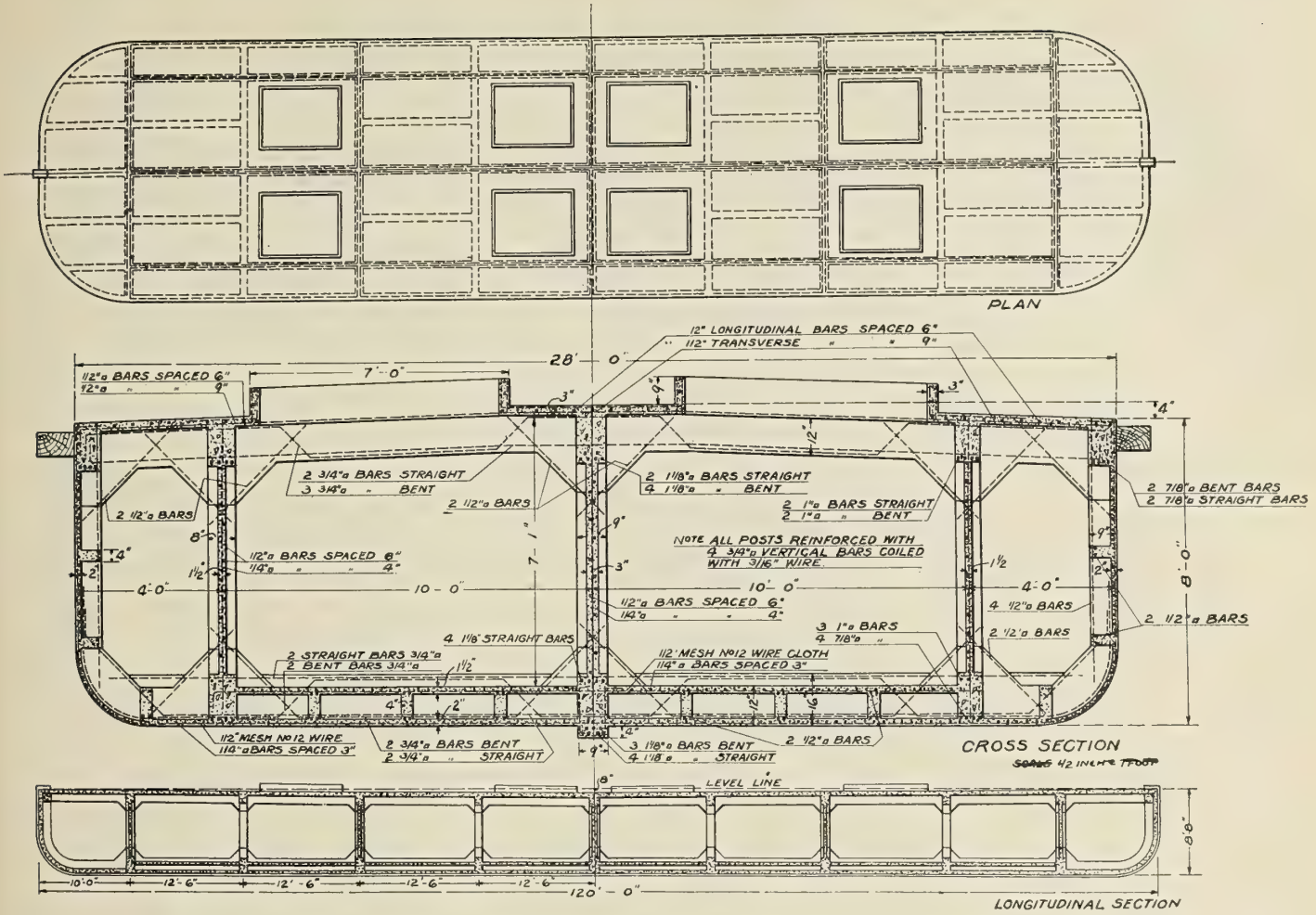


Fig. 1.—Design for Reinforced Concrete Barge, 120 Feet by 28 Feet by 8 Feet Depth

upon one wave under the center, seems to be the point about which there is the most skepticism. It may be stated, however, that with the exercise of ordinary skill in design and construction there should be no more liability of failure with reinforced concrete than with any other structural materials. It cannot be too strongly emphasized, however, that a thorough knowledge of the theory of design is essential as well as experience and vigilant inspection during construction.

That a ship of reinforced concrete can be built safely to withstand these stresses and yet compare favorably with a steel ship, as far as weight is concerned, may be clearly realized after giving due consideration to the characteristics of these two forms of construction. The resistance of a steel ship to longitudinal bending is limited to the strength and efficiency of its riveted joints and connections, which are extremely susceptible to "working" under the alternating loads imposed, and therefore the true strength of the ship is in the shear of its rivets and rivet holes, which is but a small percentage of the tensile strength of the steel taken through any section of the ship.

Shearing Stresses in Concrete Ship

In a reinforced concrete ship all the shearing stresses occurring in the structure may be taken up by direct tension in the steel, thus utilizing the steel so as to benefit by its strongest properties. There are no rivets or the like to work loose and thus accentuate the deflections and the resulting stresses. The safety of a reinforced concrete structure increases with age, the concrete growing harder and the bond with the steel becoming stronger. The coefficient of bond between the concrete and steel has been determined within safe limits, and with proper design there need be no danger of the steel pulling out.

Recent scientific experiments, as well as actual practice, have proved reinforced concrete to be safe under repeated and vibrating loads. It absorbs these recurring shocks as no other material does, and would materially lessen the machinery vibrations experienced in steel ships.

Distinctive Advantages of Reinforced Concrete Ship Construction

Chief among the distinctive advantages of reinforced concrete is its great length of life as compared with either steel or wood. While these materials tend to decay or corrode in a very short time when subjected to the action of sea water and its animal life, concrete, if well proportioned, of first-class materials and properly applied, is absolutely impervious to the action of sea water and proof against boring animal life. If a first-class cement is used with a clean, coarse, sharp sand and a well proportioned aggregate, in the proportion of at least 1 : 1½ : 3, a good, strong, dense concrete of indefinite life will result.

Concrete expands and contracts with changes of temperature. Its coefficient of expansion, that is, its expansion per unit length per degree rise of temperature, is almost identical with that of steel, and on this account there is no tendency of the two materials to pull apart, but they act together under all conditions. In such a structure as a ship, free to expand or contract unrestrainedly, there need be no special provision made to care for this, as is necessary in a large bridge, building or dam.

Reinforced concrete ranks high with the best fireproof materials, and on this account is a material much to be desired for ship construction. The fire resistance of concrete grows with age, as does its strength, as the water held in its pores is gradually taken up chemically and is evaporated.

A reinforced concrete ship is monolithic throughout, just as if it had been carved out of a solid rock. The frames, beams, girders and stringers are continuous from side to side and from stem to stern of the ship, while even the hull and decks form integral parts of these members, as do the columns, the entire structure being tied together by the reinforcing steel.

All this accounts for the extraordinary stiffness and solidity of a reinforced concrete structure, and differentiates it from timber or steel construction where either positive joints occur over the columns, as in timber construction or where all the connections are riveted joints, as in steel construction.

This solidity and entire lack of joints especially adapts reinforced concrete for use under varying and alternate loading and to heavy and high-speed machinery. The vibrations are deadened and taken up in a way which is impossible in a steel structure.

Steel rods are set in the concrete to provide for tension in such amount and where needed for any special loading for which it may be designed. Consequently spans can be constructed of any reasonable length and column spacing may be adopted to meet the requirements of the situation.

The speed with which a reinforced concrete ship can be constructed is much quicker than with any other material, because, in the first place, there need be no waiting for materials. Sand and stone are always available; large quantities of cement are always kept in storage by the mills, and steel rods are kept in stock by all dealers, so that a ship can be commenced as soon as the plans are completed and no delays need be incurred in ordering special shapes and awaiting their shipment from the mills.

Cost of Ship Construction

As a fundamental principle of economics the cost of a ship must be such that the outlay for interest on the first cost, operation and maintenance shall be as small as possible, consistent with the requirements of good design and the purpose for which intended. A wooden ship is the cheapest in first cost, and therefore in interest charges, but has a short life and is most expensive in repairs and in insurance. However, with the present high cost of good timber, it will frequently be found that the cost of reinforced concrete is cheaper than timber, and with its much longer life and minimum of upkeep charges the economy of this class of construction is very apparent.

The exact cost of a ship in any case is governed by the local conditions, and in reinforced concrete construction the same ruling applies. The design, the loading for which it must be adapted, the price of cement, the cost of obtaining suitable sand and gravel, the price of form lumber, the construction methods adopted for doing the work, the price of reinforcing steel, the wages for laborers, carpenters, and so forth, all are factors entering into the estimate. However, in reinforced concrete work by far the greater portion of the work is done by common labor, and therefore the high rates of skilled labor will affect the cost of a ship built of this material less than it will the cost of any other structural material.

The economic aspects of the use of reinforced concrete for ship construction are demonstrated to some extent by the following examples worked out by the author, and it is believed these could be much improved upon.

Fig. 1 shows the general plan of one of a fleet of concrete barges designed for the transportation of crude salt about San Francisco Bay and river points. The length is 120 feet overall with a breadth of 28 feet and a depth of 8 feet. The hull is divided into watertight compartments by longitudinal and transverse bulkheads, and is provided with heavy projecting wooden fenders to guard against collision. The deck is 3 inches thick and fitted with large trunk hatches to each compartment, providing for easy loading and unloading. Light wooden hatch covers or canvas awnings will be fitted over the hatches. The weight of the hull complete will be about 258 tons and will draw about 2 feet 7 inches of water in the light condition.

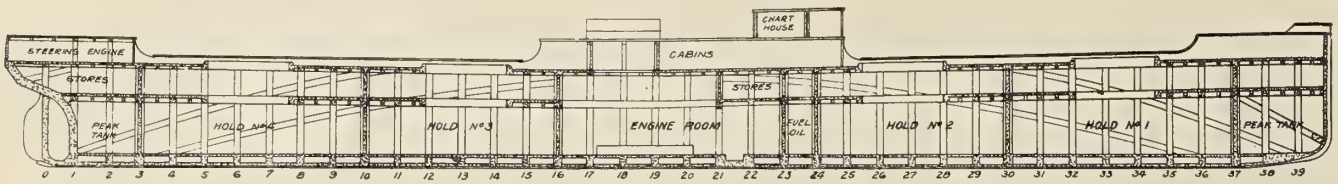


Fig. 2.—Longitudinal Section—Reinforced Concrete Freighter, 330 Feet by 43 Feet by 26 Feet; Displacement, loaded, 7,000 Tons; Cargo Capacity, 2,500 Tons; Indicated Horsepower, 2,000; Speed, 12 Knots

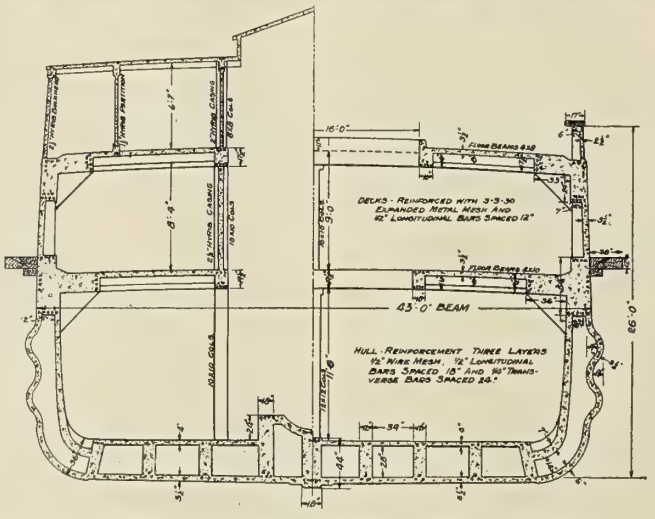


Fig. 3.—Transverse Section, Reinforced Concrete Freighter

The cargo capacity will be about 400 tons on a draft of 6 feet 6 inches.

The principal advantages of this design over wood or steel are low first cost and low cost of maintenance. In Table I is shown the estimated cost for the concrete barge in comparison with barges of the same size built of creosoted pine and of steel. These figures are based on the present price of materials and the cost of labor.

The repair charge of the wooden barge is the average cost of repairs on 31 different wooden barges built of treated lumber and the repairs for the concrete and the steel barges are estimated. The charge for interest on repairs is based on the average yearly repair charge and

the interest computed over half the number of years of the estimated life of the barge.

TABLE I

	Reinforced Concrete	Wood	Steel
Estimated life, years	35	15	25
Displacement (light), tons	259	135	151
Pounds per cubic foot capacity	19.25	10	11.2
Cost per cubic foot	.318	.304	.687
First cost	$8,547	$8,171	$18,466
Total cost of repairs	855	2,432	1,847
Interest on first cost at 5 per cent	15,000	6,128	23,082
Interest on repair cost at 5 per cent	7,500	912	11,541
Total cost	$31,901	$17,643	$54,935
Total annual cost	$911.5	$1,176.2	$2,197.4

Fig. 2 shows a design for a small ocean-going freight vessel. The principal dimensions are: Length between perpendiculars, 312 feet; beam molded, 43 feet; depth molded, 26 feet, and a total displacement of 7,000 tons.

The proposed method of construction is as follows:

Hull, material, plaster concrete of 1 : 1 : 2 mix, using ¼-inch stone. Reinforcement, wire mesh and ½-inch longitudinal bars. Mesh to be secured by wiring to reinforcement of frames and to longitudinal bars on outside. Concrete to be plastered to the inside of the mesh and then brought to the required thickness by using the cement gun on the outside, thoroughly imbedding the mesh, rods, and a second lighter mesh close to the outside surface. The outer surface will be brought to a hard troweled finish.

Frames, posts, stringers, beams, keelsons and girders to be of 1 : 2 : 4 stone concrete cast monolithic in place, reinforcement, square and round bars. Forms to be erected and the concrete placed by the pneumatic system of mixing and placing.

Inner bottoms and bulkheads to be 1 : 2 : 4 stone concrete precast in slabs, transported to position and grouted in place. Proper provision will be made in all slab work for making efficient connections of all reinforcement and joints to develop the full strength of the steel.

Decks will be monolithic of 1 : 2 : 4 stone concrete cast in place by the pneumatic method, reinforced with ½-inch square bars both ways.

All deck houses and superstructure will be of plaster concrete of 1 : 3 mix applied to Hy-rib metal lath by the cement gun.

Ferro-Concrete Vessels*

The fact that the building of ferro-concrete vessels has been commenced on a fairly large scale, first in Norway and now also in Sweden and Denmark, has naturally centered a considerable amount of technical interest on the question. In Sweden it has been discussed at some length, both in the technical press and at meetings of engineers.

One of the points which has been insisted upon by opponents of the material is the inability of concrete to resist the influence of salt water, however excellent it admittedly is in fresh water. The danger arises from the lime liberated, in the process of hardening, entering into combination with the sulphuric acid and magnesium salts of the salt water. At the instance of the German Concrete Union, the Prussian Department for Public Works, and other authorities, some extensive tests were commenced at the island of Sylt in the North Sea, and these tests have not yet been terminated. Concrete blocks were laid on the shore, fully exposed to the chemical and mechanical influences of the sea. The blocks were molded in two mixtures, A and C, the cement of the former containing about 65 percent of lime, and that of the latter only 61 percent to 62 percent. But the latter was richer in alumina and iron, 10 percent to 12 percent, against 6 percent to 8 percent in A. The concrete blocks were so placed on the shore that at high water they were entirely submerged, and at low water only partly so. After as little as two to three years the C blocks, even such as were molded in mixtures 1 : 2, showed fine cracks, and after three to four years the surfaces had all suffered much. The A blocks, in a rich mixture, stood the test better, and in mixtures 1 : 2 they were unaffected after four to five years; with poorer mixtures, 1 : 4, the edges had suffered, and with still poorer mixtures were much affected after as little as one to two years.

Recent experiments in the United States have shown that an addition of 5 percent of finely ground clay to a mixture 1 : 3 : 6 rendered it more resistant, also more so than the same mixture with 10 percent of lime added. On the whole, however, all the test blocks suffered more or less.

In spite of all this there are numerous cases in which concrete has withstood the influence of salt, even very salt, water quite satisfactorily; it is in almost universal use for harbor works, etc. The current explanation of the unfavorable effect of salt water upon concrete is that the sulphate of magnesium in the water combines with the lime in the concrete, forming sulphate of calcium, which is of larger volume and therefore has a bursting effect upon the concrete. There are, however, many other kinds of cement, and especially cement of the so-called puzzolane type, not only free from a surplus of lime, but with a surplus of silicic acid, and thus able to bind free lime. The addition of such kinds of cement and other substances containing silicic acid has therefore for a series of years been used as a protection against the undesirable effects of salt water.

In the reports for 1915 from the Gross Lichterfelde West Material Testing Institution some exhaustive laboratory experiments as to the influence of different solutions upon concrete mixtures of 1 : 3 and 1 : 6 were dealt with.

The 1 : 6 concrete was all more or less affected, but all the 1 : 3 concrete tests showed that no harm had been done to the concrete, except in one case, in which the block had been kept in a closed exsiccator during the hardening, and had been submerged in sulphate of calcium solution. The use of too much fine sand in the mixture is undoubtedly injurious. This was shown very plainly in *Le Cement* last year. The unsatisfactory result of the American tests already referred to may to a great extent be attributed to the very fine sand which was used for the mixtures.

It is clearly evident that concrete can only be affected by sea water to the extent that water penetrates it. If the concrete is sufficiently dense, nothing but the surface is exposed to any risk, and the making of dense concrete is no longer a novelty.

Protective measures in the construction of concrete vessels may be summed up as follows: (1) The use of rich concrete; (2) the use of cement with but little free lime, gypsum and alumina; (3) the addition of puzzolane to fix the free lime; (4) the use of coarse sand; (5) the use of dense concrete; (6) surface treatment. Should the cement boat-building industry develop there should not be much trouble in guarding against decay if full use be made of our present knowledge.

In conclusion the advocates of concrete as shipbuilding material urge that concrete in any case is more resistant than steel. The fact remains that reinforced concrete vessels are in existence and are being built, although it is premature at present to express any definite opinion as to their durability and strength.

* From *Engineering*.

J. F. DUTHIE & COMPANY, SHIPYARD

Seattle's Latest Addition to the Shipbuilding Industry

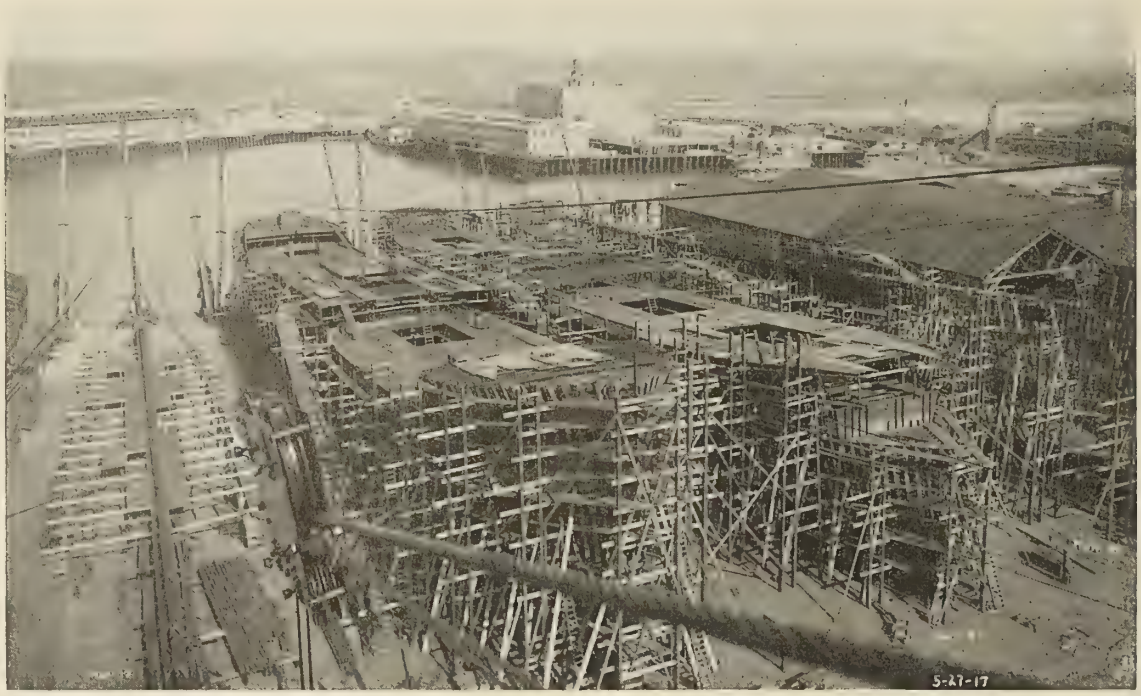


Fig. 1.—General View of Building Slips

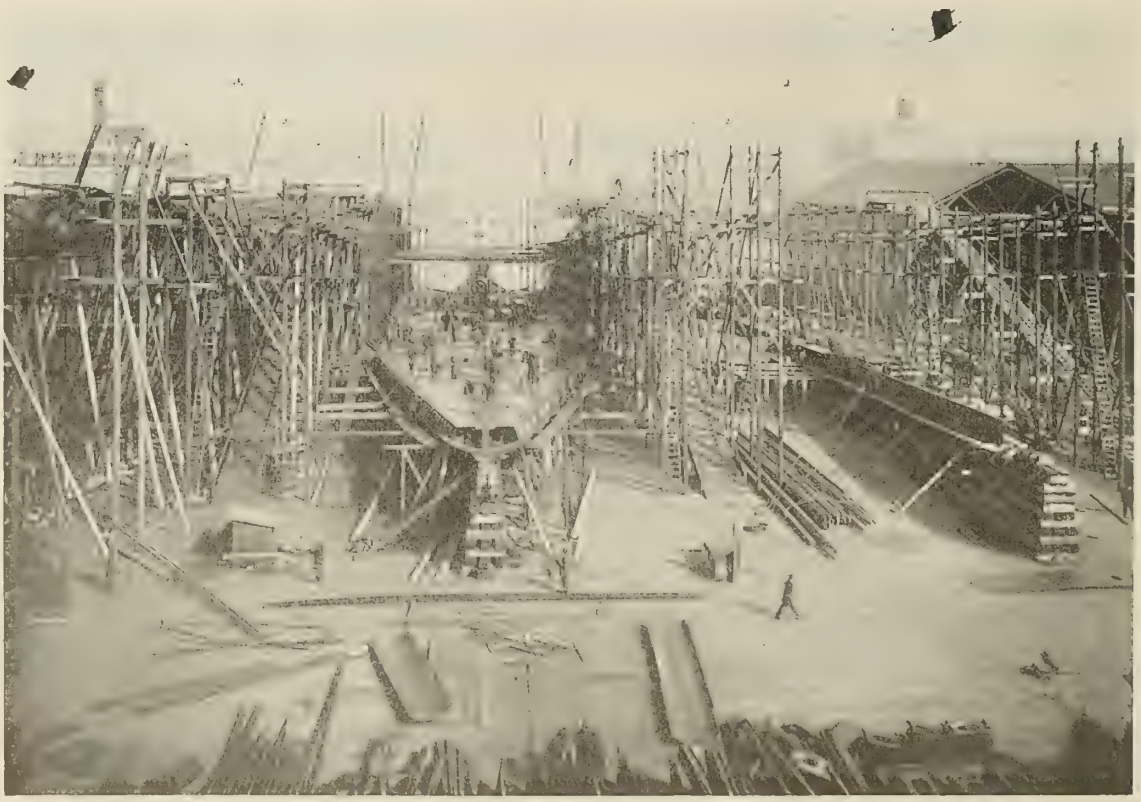


Fig. 2.—Head of Building Ways, Showing Aerial Tramway System and Storage Space for Fabricated Sections and Material

Fig. 3.—Panoramic View of the Duthie Shipyard

J. F. Duthie & Company Shipyard

**Another Addition to Seattle's Shipbuilding Industry—
Plant Covers Twelve Acres, with Four Building Slips**

SITUATED on Seattle's East Waterway and covering approximately twelve acres of ground is the new steel shipbuilding plant of J. F. Duthie & Company, well-known ship and engine builders of the Northwest. This plant, while entirely new and separate from the former J. F. Duthie establishment, emanated from the efforts put forth by Mr. Duthie, who has many years of successful ship and marine engine building to his credit.

The plant is located on a portion of what was once the Seattle tidelands, but which property was made extremely valuable for industrial purposes by filling in with sand and earth taken by suction from the adjacent waterway, thereby making a deep and navigable channel alongside.

Layout of Buildings

Extreme care and forethought were taken in the general layout of this plant, which is up-to-date in every particular, about one-third of the complete plant area being under cover. The many crane and locomotive tracks advantageously arranged permit the handling of the material to be used for construction with the least possible effort.

The material, when ready for setting up on the respective ships, is handled by aerial tramways, a system now extensively used in the Northwest. The conveyor winches are placed on substantially built platforms high in the air and a considerable distance forward of the bows of the ships, thus enabling the winch operators who are also stationed on these platforms to have an unobstructed view of the ships which they are serving and giving ample room between the ships and the forward uprights for the handling and stowing of material and built-up sections until ready for installation on the various ships. The after uprights of this aerial system, unlike any of the other yards on Puget Sound, are placed at a very acute angle to the ground and lean out toward the water. In this way, when large loads are carried, the tension in the stay is made less than if the upright were placed perpendicular; a great portion of the stress being taken up by the thrust created in the upright.

Shops and Equipment

The plate and angle shop, which is about 900 feet long, is equipped with all the modern devices for handling and fabricating the material. It is spanned by an overhead traveling crane which runs the length of the shop, distributing material to the individual wall or jib cranes, fitted with pneumatic travelers and hoists, which in turn serve their respective punches, shears, beam benders, rolls, planers, etc.

The blacksmith shop and machine shop are located parallel to the plate and angle shop, but on the opposite side of the yard, the intermediate space containing the four building slips which are now all occupied. These two shops are built in one, so that castings and blacksmith work in general, requiring machining, may be conveyed directly from one building to the other by an overhead crane similar to the one in the plate and angle shop and connecting both buildings. These shops are also fitted with the most up-to-date equipment available. In the wings of the machine shop are located shops for copper

J. F. DUTHIE & COMPANY SHIPYARD

Seattle's Latest Addition to the Shipbuilding Industry

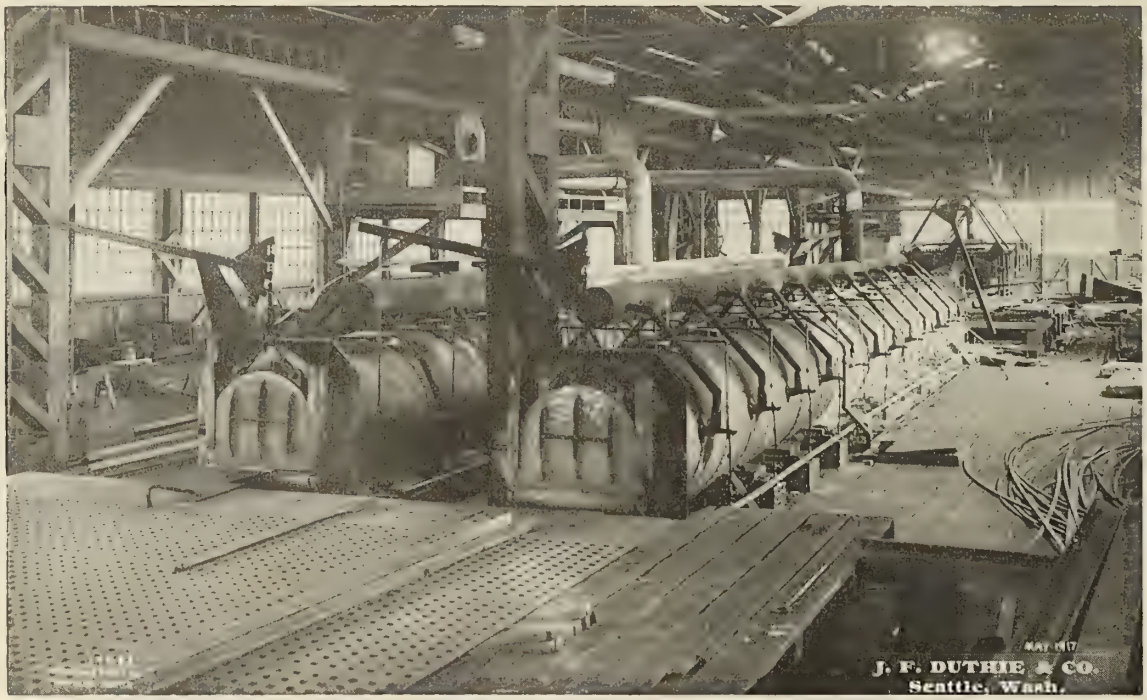


Fig. 4.—Plate and Angle Furnaces and Bending Slab

Fig. 5.—Interior of Mold Loft

J. F. DUTHIE & COMPANY SHIPYARD

Seattle's Latest Addition to the Shipbuilding Industry

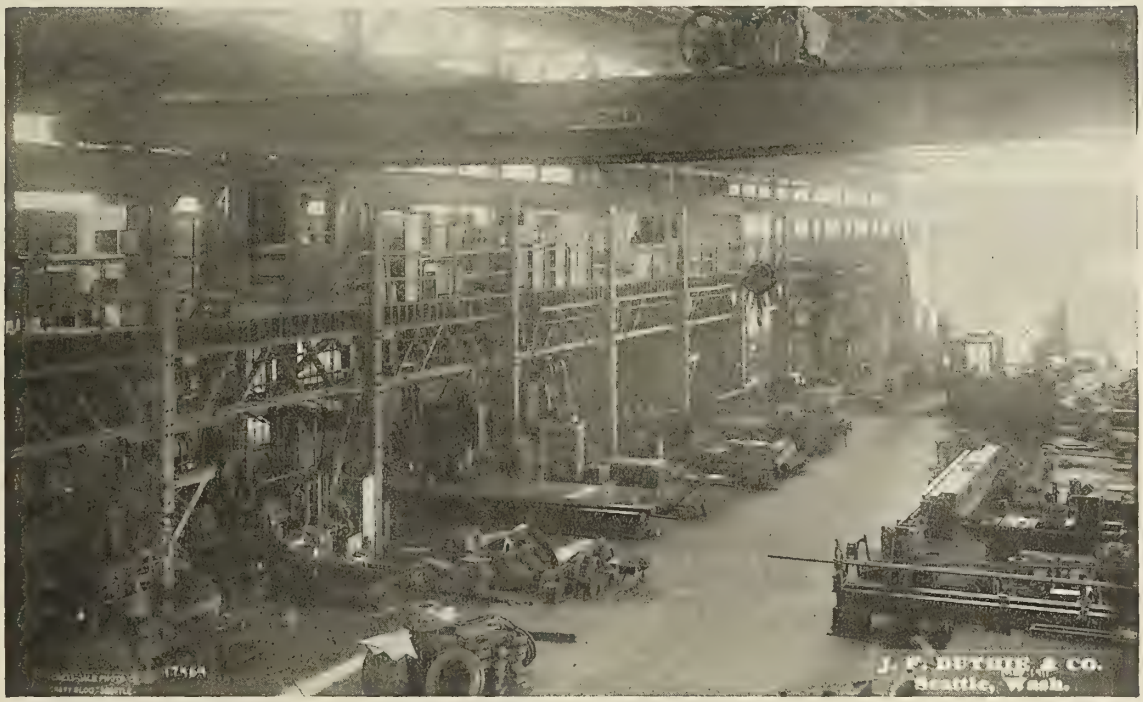


Fig. 6.—Section of Machine Shop

Fig. 7.—Plate and Angle Shop

Fig. 8.—Blacksmith Shop

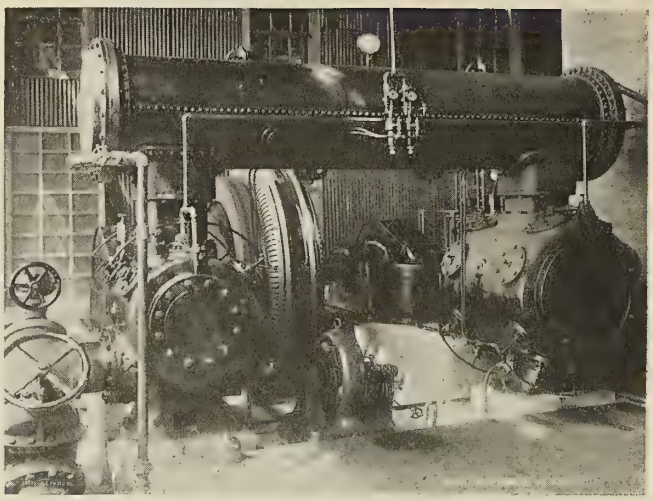


Fig. 10.—Part of Power Plant

and sheet metal working, pipe fitting, storage rooms, etc.

Adjacent to the plate and angle shop and at right angles to it are the furnaces. These are three in number, two being used for angles and one for plates; fired by fuel oil and steam and constructed of steel shells lined with fire brick.

The carpenter, pattern making and joiner shops are also located in one building, space having been given to a certain portion for the storage and natural drying of lumber. These shops are as fully equipped as a wood-working mill, and care has been taken in furnishing a generous supply of light.

In this latter respect the mold loft, too, excels those of many of the other shipyards. It is located on ground level and the sides are paneled in glass, permitting light to come in from all directions. The floor is painted gray instead of the heretofore and much used black, making a much easier color to work by. Storage space has been maintained for the templates, for as the ships being built are all of the same type, these templates can be used over and over again.

Storage Yard

Alongside of the plate and angle shop is the storage space for shapes and plates. All the material in this space is handled by two derricks having booms capable of covering an area of about 160 feet in diameter each, the derrick booms having an out-reach of approximately 80 feet. This storage space is directly connected with the railroad tracks of the various trans-continental railroads.

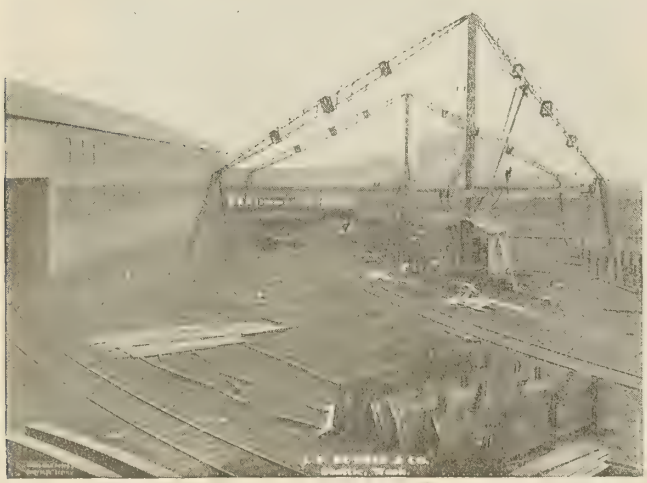


Fig. 9.—Storage Yard, Showing Erection of 80-Foot Booms for Handling Material

All the buildings are of heavy mill construction and are made up of members sufficiently great to withstand the shocks usually caused by loaded cranes. Due to the immense amount of timber used, efficient fire protection methods were immediately installed.

Building Slips

Between the plate and angle shop and the machine and blacksmith shops are the building ways, four in number. These lead out into East Waterway, where there is a good depth of water and an open area sufficiently large to launch with ease any of the modern type cargo vessels now building.

Hospital and Restaurant

The hospital, with a nurse always in attendance, is also located on the grounds. This building, while not large, is fully equipped for the purpose intended and a physician is on duty during most of the day.

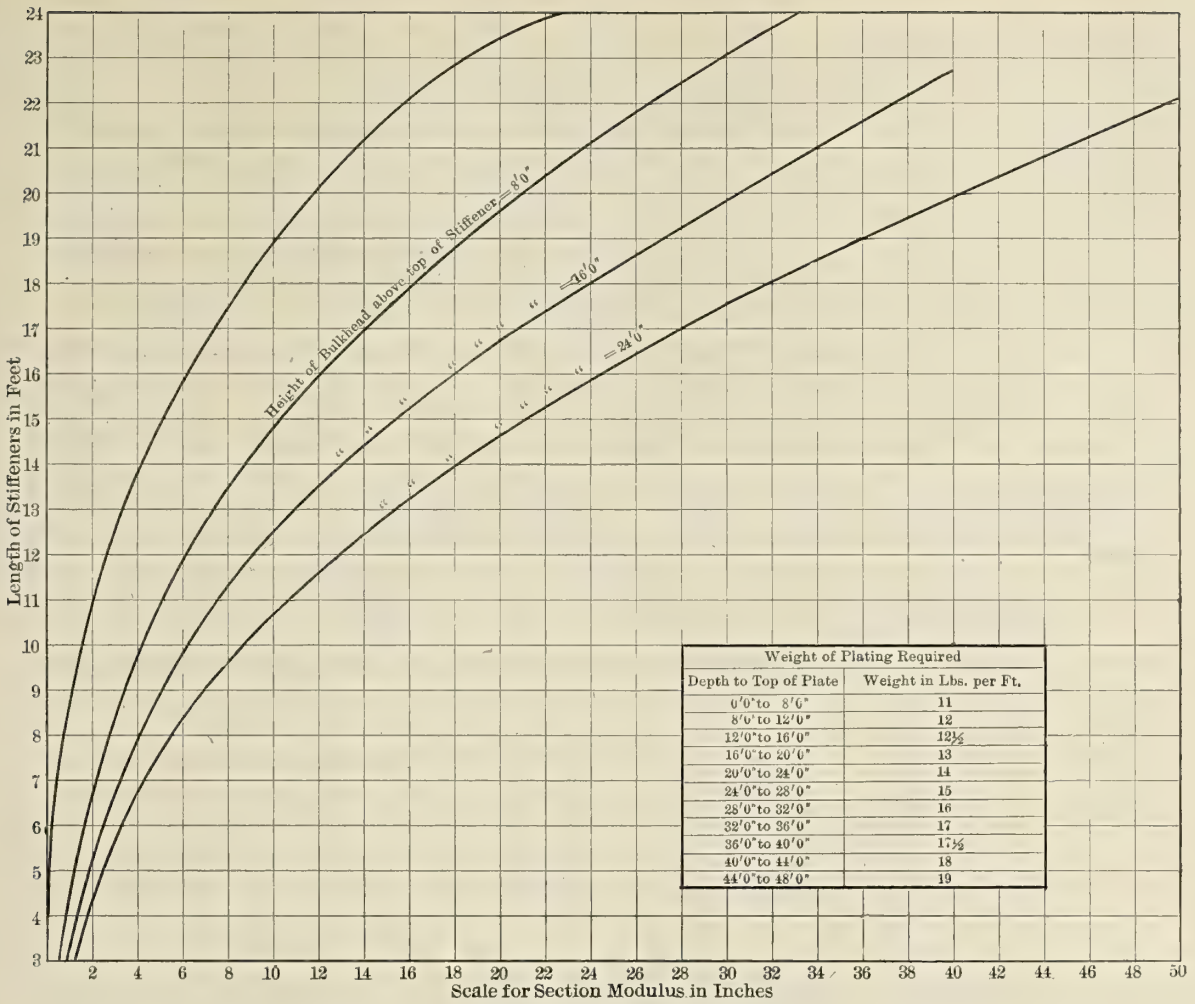
For the convenience of the employees a restaurant is maintained nearby, as the distance to the main section of Seattle is too great to be reached within the prescribed noon hour.

The plant is working in three shifts and has at present contracts for ten ships, all of 8,800 tons deadweight.

Correction

In the article on "Standardized Geared Turbines for Cargo and Passenger Steamships," published on page 255 of our June issue, several numerical errors inadvertently occurred. In the third paragraph of the article it is stated that the 1,500 horsepower unit "occupies a space of 21 feet long by 9 feet wide by 8 feet 8 inches high; that is, 164 cubic feet, or equivalent to about 9 horsepower per cubic foot." These figures should, of course, read "1,640 cubic feet" and "0.9 horsepower." Similarly, the space occupied by the 2,500 horsepower unit is approximately 1,800 cubic feet or 1.4 horsepower per cubic foot.

Change of Address.—Offices of the National Shipbuilding Company, New York, which were formerly in the Grand Central Terminal, have been changed to 120 Broadway.



Weight of Plating Required	
Depth to Top of Plate	Weight in Lbs. per Ft.
0'0" to 8'0"	11
8'0" to 12'0"	12
12'0" to 16'0"	12½
16'0" to 20'0"	13
20'0" to 24'0"	14
24'0" to 28'0"	15
28'0" to 32'0"	16
32'0" to 36'0"	17
36'0" to 40'0"	17½
40'0" to 44'0"	18
44'0" to 48'0"	19

Fig. 1.—Section Modulus of Vertical Bulkhead Stiffeners as Required by Lloyd's Rules, Spacing 30 Inches Centerline to Centerline

Data for Bulkhead Construction

Curves Giving Section Modulus of Bulkhead Stiffeners Required by Lloyd's Rules from Length of Stiffener

BY F. K. RUPRECHT

LLOYD'S rules for the construction of ships are widely used throughout the world and are modern in every way. The tables for the scantlings of bulkheads embody all the latest available information on the subject and have been kept up with the recommendations of the Bulkhead Committee.

The tables given for the size of vertical stiffeners on watertight bulkheads are all Standard British Sections. Only a few of these sections are available in this country and even when obtainable carry an extra charge and are rolled only by special arrangement with the mill. It is troublesome to convert these sections into sections obtainable in this country because comparatively few complete tables of Section Modulus of Standard British Sections are to be had. With this fact in mind the following curves shown in Figs. 1, 2 and 3 have been plotted, giving the required section modulus as called for by Lloyd's rules for watertight bulkheads directly from the length of the stiffener. Having the Section Modulus it is a very simple matter to choose a section from the steel mills' shape books, which will fill the requirements to hand.

At the outset of this problem it was found that to cover every possible case a great number of curves would be needed. Owing to this an attempt has been made to simplify the curves but still to include all practical conditions. In the case of a single-deck vessel no assumptions are necessary, since the length of stiffeners is the only question involved. However, in all other cases we have to deal with the height of bulkhead above the top of the stiffener in question. This involves the height of the 'tween decks. In this case a standard height of 'tween deck of 8 feet has been assumed. This is a pretty well standardized figure and in only a few cases will the variation from this height be great enough to affect the required section modulus of the lower stiffeners of the bulkhead. The assumption made appears reasonable and has simplified the curves to a large degree without, in the average case, limiting their application.

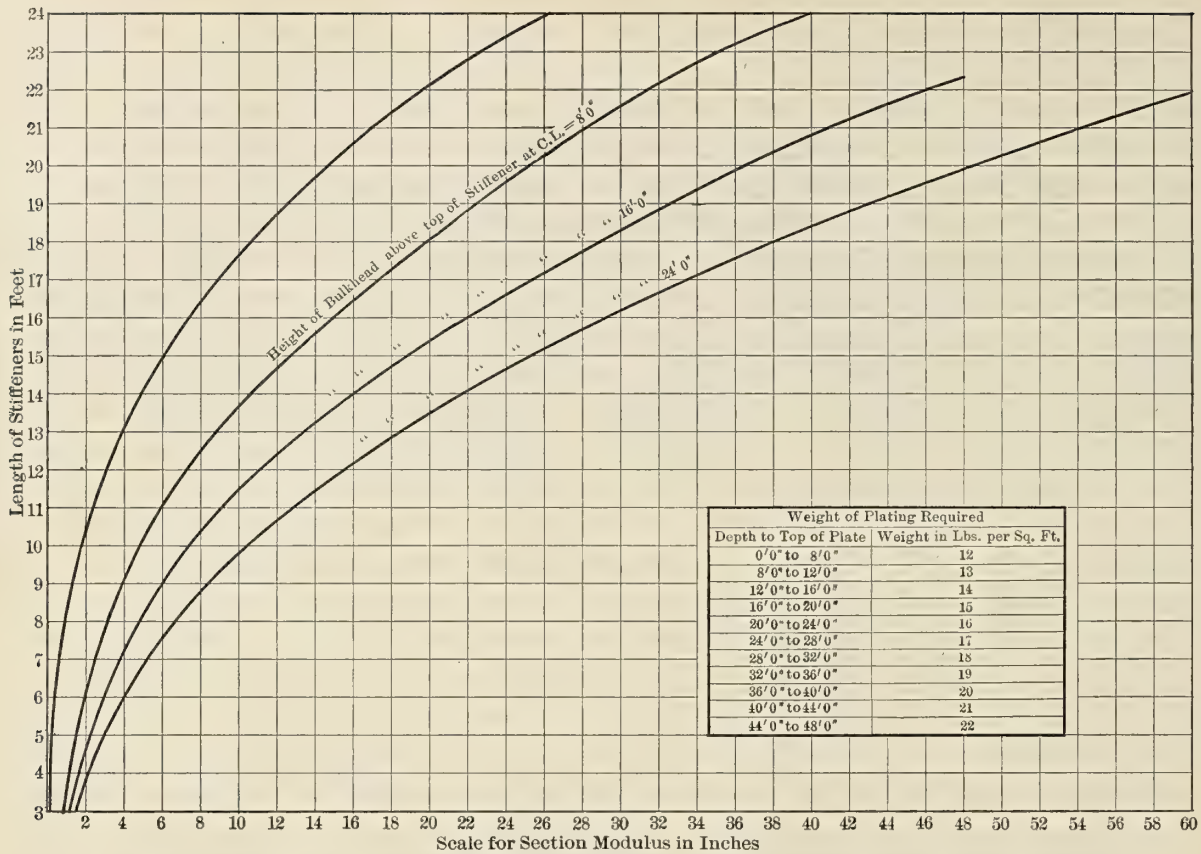


Fig. 2.—Section Modulus of Vertical Bulkhead Stiffeners as Required by Lloyd's Rules, Spacing 36 Inches Centerline to Centerline

As can be understood when plotting the section modulus for the stiffeners as given above in Lloyd's rules, the values were not always found to be on a fair curve. It was necessary in drawing the curves to fair them in with as many points as possible. Any variation from the points is, however, small and the values as given are perfectly safe. Again, in figuring back from the curves a section will seldom be found which will exactly fill the requirements as to section modulus, and it would be advisable at all times to select a section with a slight excess of strength than one under the requirements of the curves.

The tables as given by Lloyds give the required stiffeners when spaced 30 inches on centers only; the required section moduli for this spacing are given in Fig. 1, but the rules permit any spacing up to a maximum of 36 inches, although the necessary increase in size of section is not given by the rules. It is known that the bending moment on a vertical bulkhead stiffener increases directly as the width of plating supported and that the required section modulus increases directly as the bending moment. On this basis a set of curves (Fig. 2) of the required section modulus of stiffeners when spaced 36 inches on centers has been plotted. Now in actual practice it will seldom be possible to have our stiffeners on an exact 30-inch or 36-inch spacing, so that it would be desirable to interpolate between these two conditions. To make this possible a set of curves (Fig. 3) has been plotted, showing the increase in the required section modulus of stiffeners for every increase in spacing of 1 inch over 30 inches. These curves have been plotted on the same basis as the other curves and their application is very simple and rapid. It is believed that this curve will prove of value.

To increase the completeness and usefulness of these curves tables have been added giving the thickness of plating required for the two standard spacings of stiffeners as given in Lloyd's rules. The weight of plating required for any intermediate spacing of stiffeners can be arrived at by interpolation between the weights given.

All measurements for the length of stiffeners are to be total heights from heel of shell, tank top or deck bars to underside of deck plating, i. e., molded height, at the center line of the ship. In the case of longitudinal bulkheads not on the center line of the vessel the height from the heel

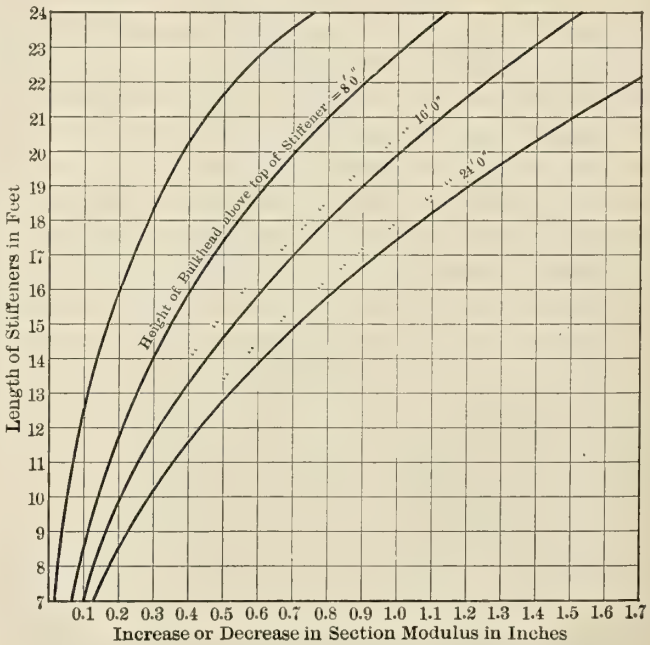


Fig. 3.—Curves for Increase or Decrease in Section Modulus for Increase or Decrease in Spacing of Stiffeners of One Inch

of the lowest shell, tank top or deck bars to underside of deck should be used for entering the curves.

The height of the 'tween decks is to be taken on the center line of the ship.

As can be seen by the curves the application of these data is fairly wide and should cover all ordinary vessels constructed for cargo purposes. They are, of course, only applicable to vertical stiffeners on watertight bulkheads up to the following limits:

1. Single-deck vessels: (a) Single bottom up to 24 feet molded depth; (b) double bottom up to 26 feet molded depth.

2. Two-deck vessels: (a) Single bottom up to 32 feet molded depth; (b) double bottom up to 34 feet molded depth.

3. Three-deck vessels: (a) Single bottom up to 40 feet molded depth; (b) double bottom up to 44 feet molded depth.

4. Four-deck vessels: (a) Single bottom up to 48 feet molded depth; (b) double bottom up to 50 feet molded depth.

5. The above depths are to the strength deck only. Any number of upper decks may be added above the uppermost continuous watertight deck.

A Method of Finding the Indicated Horsepower for Steamships*

Calculations Depend on Standard Block Coefficient Based on Speed and Length of Vessel—Power Derived from Trial Data of Similar Vessels

BY E. W. DE RUSSETT

THE object of this paper is to suggest a ready means of estimating the power required for the propulsion of steamers which the writer initiated some years ago and has since developed. It will be observed that the calculations circle round a standard block coefficient which is based on the speed and length of the vessel. The power of the proposed vessel is arrived at by direct reference to the trial trip records of vessels of a similar character. The inquiry embraces the following rules:

1. For basis purposes select the trial trip records of two suitable vessels, A^2 and A^3, preferably of similar design to the proposed steamer A^1.

2. Find the speeds of A^2 and A^3 which correspond to the specified speed of A^1 by the ratio of $\sqrt{L}$.

3. Obtain the speed ratio at the corresponding speeds.

4. At the corresponding speeds measure the Admiralty coefficient from the coefficient curves of A^2 and A^3.

5. Find the standard block coefficient for vessels A^1, A^2 and A^3 by the following formula

$$C - \frac{V}{\sqrt{L} \times 2},$$

where C is a constant 1.060, V and L being the speed and length respectively. Compare the block coefficient of these two vessels with the standard block.

6. When the relative fineness or fullness of the ordinary

TABLE A

—	A^1.	A^2.	A^3.
	feet inches	feet inches	feet inches
Length B. P.	452 0	481 0	391 0
Breadth, extreme	56 6	55 5	48 2
Trial draft	27 8	27 5½	20 8
Block coefficient	0.778	0.730	0.678
Coefficient of midship section	0.98	0.974	0.965
Displacement, tons	15,540	15,190	7,500
Speed required	12 knots	—	—
Corresponding speed to A^1 by ratio of $\sqrt{L}$	—	12.38	11.16
Speed ratio on corresponding speeds $\frac{V}{\sqrt{L}}$	0.565	0.656	0.565
Standard block 1.060— $\frac{V}{\sqrt{L}x2}$ at corresponding speeds	0.778	0.778	0.778
Admiralty coefficient obtained on trial at corresponding speeds	—	308	304
Relative fineness of block to standard block	unaltered	6.2 per cent finer	12.8 per cent finer
Admiralty coefficient increased by 1 percent for each 3 percent of relative fineness (Table C)	—	2⅓ percent = 6	4.3 percent = 13
Admiralty coefficient adjusted for relative fineness	—	314	317
Admiralty coefficient for A^1 ship, being mean of A^2 and A^3	315.5		
Corresponding indicated horsepower $\frac{D^{2/3} \times V^3}{C}$	3,400		
Margin on power for contingencies, 5 percent	170		
Total indicated horsepower	3,570		

TABLE B

Table Showing Estimate of Power required for a Vessel with a Cruiser Stern

	Proposed S.S.	Basis Vessels with Cruiser Sterns.	
	A^1.	A^2.	A^3.
	feet inches	feet inches	feet inches
Length, B. P.	530 0	580 0	306 0
Length on load waterline	550 0	600 0	317.6
Breadth, extreme	66 0	72 0	42 0
Trial draft, B.K.	27 0	28 5	15 0
Block coefficient	0.650	0.628	0.547
Coefficient of midship section	0.96	0.95	0.926
Displacement tons	18,080	21,920	3,118
Speed required on trial	17 knots	—	—
Corresponding speed to A^1 by ratio of $\sqrt{L}$	—	17.757	12.916
Speed ratio at corresponding speed $\frac{V}{\sqrt{L}}$	0.725	0.725	0.725
Standard block 1.060— $\frac{V}{\sqrt{L}x2}$ at corresponding speeds	0.697	0.697	0.697
Admiralty coefficient obtained on trial trip at corresponding speeds	—	345	309
Relative fineness of block coefficient to standard coefficient	†6 percent finer	9 percent finer	21 percent finer
Admiralty coefficient increased by 1 percent for each 3 percent of relative fineness (Table C)	2 percent	3 percent = 10	7 percent = 21
Admiralty coefficient adjusted for relative fineness	—	355	330
Admiralty coefficient for A^1 ship, being mean of A^2 and A^3	343		
Add one-third of the relative fineness = 2 percent of the Admiralty coefficient	7†		
Admiralty coefficient	350		
Corresponding indicated horsepower $\frac{D^{2/3} \times V^3}{C}$	9,670		
Margin on power for contingencies, 5 percent	480		
Total indicated horsepower	10,150		

*Paper read at the North-East Coast Institution of Engineers and Shipbuilders, April 27, 1917.

† In this instance the block of the proposed vessel A^1 is 6 percent finer than the standard block, as economy of power was of more importance than deadweight. Credit for this is given, as noted above, when adjusting the Admiralty coefficient.

and standard blocks has been found, correct the Admiralty coefficients at the corresponding speed ratios.

7. Of course it is prudent to have a margin of power for contingencies, and on this account it is suggested that an addition be made of 5 percent if the basis ships have been tried on the Skelmorlie mile, or 3 percent if they have been tried on the Whitley mile—the conditions being normal.

We will now refer to Tables A and B, which show the method of applying the foregoing rules. Column A^1 contains the particulars of an ordinary commercial vessel, the power for which has to be ascertained. Columns A^2 and A^3 contain the particulars of vessels which have been tried on the measured mile.

With the object of arriving at the effect of fineness of a model on the Admiralty coefficient, the writer has prepared the following Table C, with the kind assistance of Mr. H. Bocler. It is built up from the valuable paper read by Mr. Baker at the Institution of Naval Architects in 1914:

TABLE C
Effect of the Admiralty Coefficients on Models of Varying Degrees of Fineness

Models	Speed		Block		$D^{2/3}xV^3$ / I. H. P.	Admiralty Coefficient In percent to Basis Coefficient	I. H. P. at 50 perct. Propelling Efficiency
	Knots	Speed Ratios $\frac{V}{\sqrt{L}}$	—	Percent to Basis Model			
56*a*	8	0.40	0.677	8.8 percent finer	328	2.44 percent higher	695
30*b*	8	0.40	0.743	Basis.....	320	Basis.....	760
86*c*	8	0.40	0.812	9.3 percent fuller	279	12.8 percent lower	920
56*a*	9	0.45	0.677	8.8 percent finer	330	2.42 percent higher	980
30*b*	9	0.45	0.743	Basis.....	322	Basis.....	1,075
86*c*	9	0.45	0.812	9.3 percent fuller	276	14.2 percent lower	1,320
56*a*	10	0.50	0.677	8.8 percent finer	327	2.7 percent higher	1,360
30*b*	10	0.50	0.743	Basis.....	318	Basis.....	1,490
86*c*	10	0.50	0.812	9.3 percent fuller	264	15.4 percent lower	1,850
56*a*	11	0.55	0.677	8.8 percent finer	323	6.2 percent higher	1,835
30*b*	11	0.55	0.743	Basis.....	304	Basis.....	2,060
86*c*	11	0.55	0.812	9.3 percent fuller	265	12.8 percent lower	2,515
56*a*	12	0.60	0.677	8.8 percent finer	314	4.7 percent higher	2,450
30*b*	12	0.60	0.743	Basis.....	300	Basis.....	2,720
86*c*	12	0.60	0.812	9.3 percent fuller	251	16.3 percent lower	3,430
56*a*	13	0.65	0.677	8.8 percent finer	313	4.7½ percent higher	3,120
30*b*	13	0.65	0.743	Basis.....	299	Basis.....	3,470
56*a*	14	0.70	0.677	8.8 percent finer	313	11.8 percent higher	3,900
30*b*	14	0.70	0.743	Basis.....	280	Basis.....	4,600
56*a*	14.5	0.725	0.677	8.8 percent finer	312	22.4 percent higher	4,350
30*b*	14.5	0.725	0.743	Basis.....	255	Basis.....	5,640

It should be stated that the three models were for vessels each 400 feet long by 52.25 feet beam, and 23.25 draft, midship section coefficient 0.98. The displacements being for model 56*a*, 9,396 tons; model 30*b*, 10,310 tons; and 86*c*, 11,244 tons; the block coefficients being respectively 0.677, 0.743 and 0.812. The parallel middle bodies varied in length from 42 feet to 200 feet. It will be noticed when the basis model 30*b* was fined to the extent of 8.8 percent, the displacement reduced by 914 tons, and propelled at speeds 8, 9 and 10 knots (speed ratios 0.40 to 0.50), that the Admiralty coefficient was only raised on an average of 2.52 percent, or one-third of the percentage that the model was fined. When steaming under the same conditions at 11, 12 and 13 knots (speed ratio 0.55 to 0.65) the average Admiralty coefficient then rose by 5.4 percent above the basis model 30*b*, or about one-half of the percentage by which the model was made finer, and it was not until the speed of model 30*b* had been increased to 14 and 14½ knots (speed ratio 0.70 to 0.725) that the increase in the Admiralty coefficient was very pronounced, the average having risen to 17 percent above model 30*b*. When the basis model was filled out 9.3 percent and displacement increased by 934 tons, the effect on the coefficient was very apparent, it being reduced by a greater degree than had been gained by fining the model.

It is not intended that the standard block shall be unalterable; it is subject to amendment according to the exigencies of the case—but when any deviation occurs the percentage of relative fineness will, of course, be attended to, as illustrated in Tables A and B. It may be of interest to observe here that the block of the famous *Mauretania* was the same as the standard block herein referred to, when steaming at full speed on her forty-eight hours' trial.

A Submarine of One Hundred and Twenty Years Ago: Invented by Robert Fulton

BY F. B. C. BRADLEE

By most people the submarine is regarded as a recent invention, yet nearly 120 years ago Robert Fulton, the inventor of the world's first practical steamboat, perfected a submarine craft which it would seem would have been entirely successful after a few more trials and a little less scepticism on the part of the authorities.

In December, 1797, Fulton, who was then living in France, made an experiment in company with Mr. Joel Barlow (the United States Minister to France) on the Seine with a machine which he had constructed and by which he designed to impart to carcasses of gunpowder a progressive motion under water to a given point and there explode them. Although he was disappointed in the performance of this machine, he continued to employ his mind until he had perfected the plan for his submarine boat, as it was afterwards executed.

A want of funds prevented Fulton from carrying his plans into execution and he was induced to apply to the French Directory. They at first gave him great reason to expect their countenance and encouragement; but, after a long and irksome attendance on the public offices, to his great surprise and disappointment he received a note from the Minister of War informing him that the Directory had totally rejected his plan.

NAPOLEON TAKES UP FULTON'S PROJECT

But the French government changed. Napoleon placed himself at the head of it with the title of First Consul. Mr. Fulton soon presented an address to him, soliciting him to patronize the project of submarine navigation and praying him to appoint a commission with sufficient funds and powers to give the necessary assistance. The request was immediately granted and the famous scientists Volney, La Place and Monge were named the commissioners.

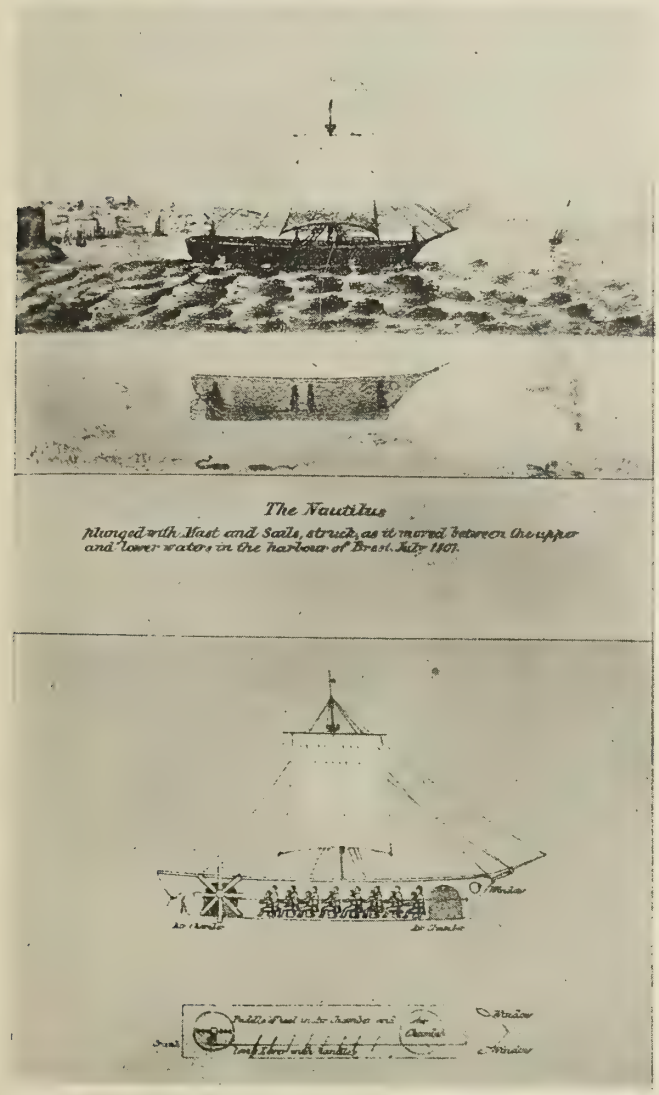
In the spring of the year 1801 Mr. Fulton repaired to Brest to make experiments with the plunging boat he had constructed the preceding winter. This had many imperfections natural to a first attempt of such complicated combinations. On July 3, 1801, he embarked with three companions on board his plunging boat in the harbor of Brest and descended in it to the depth of 5, 10, 15 and so on to the depth of 25 feet; but he did not attempt to go lower because he found that his imperfect machine would not bear the pressure of a greater depth.

Fulton and his companions remained below the surface one hour. During this time they were in utter darkness. Afterwards he descended with candles; but finding a

great disadvantage from their consumption of vital air, he had made before his next experiment a small window of thick glass measuring an inch and a half in diameter, just sufficient light to enable him to count the minutes on his watch.

Having satisfied himself that he could have sufficient light when under water, that he could do without fresh air for a considerable time, that he could descend to any depth and rise to the surface with facility, his next attention was given to his craft's movements on the surface as well as beneath it.

On July 26 he weighed his anchor and hoisted his sails; his boat had one mast, a mainsail and a jib. There was



Sketches of the Nautilus, Reproduced from Early Drawings

only a light breeze, but it was found she would steer and sail as well as any common sailboat. Fulton then struck her mast and sails, to do which and prepare the boat for plunging required about two minutes. Having plunged to a certain depth he placed two men at the engine which was intended to give the boat progressive motion, and with one man at the helm Fulton himself managed the machine which kept her submerged. He found that with the exertion of one hand only he could keep her at any depth he pleased. The propelling engine was then put in motion and he found upon coming to the surface that he had in about seven minutes made a progress of 500 yards.

He then again plunged, turned her round while under water and returned to near the place from which he started. Mr. Fulton repeated his experiment several days successfully and became familiar with the operation of the machinery and the movements of the boat. He found that she was as obedient to her helm under water as any boat could be on the surface and that the magnetic needle traversed as well in the one situation as in the other.

On August 7 Mr. Fulton again descended, with a store of atmospheric air compressed in a copper globe of a cubic foot capacity, into which 200 atmospheres were forced. Thus prepared he descended with three companions to the depth of about five feet. At the expiration of an hour and forty minutes he began to take small supplies of pure air from his reservoir and did so as he found occasion for four hours and twenty minutes. At the expiration of this time he came to the surface without having experienced any inconvenience from having been so long under water.

Fulton's Experiments Successful

Mr. Fulton was highly satisfied with the success of these experiments. It determined him to try the effects of these inventions on the English ships which were then blockading the coast of France and were daily near the harbor of Brest. His boat at this time he called the submarine boat, or the plunging boat; he afterwards gave it the name of the *Nautilus*. Connected with this machine were what he then called submarine bombs, to which he subsequently gave the name of torpedoes. This invention preceded the *Nautilus*. It was his desire of discovering the means of applying his torpedoes that turned Fulton's thoughts to a submarine boat.

Satisfied with the performance of his boat, his next object was to make some experiments with his torpedoes. A small vessel was anchored in the roads. With a bomb containing about twenty pounds of powder he approached to within 200 yards of the anchored vessel, struck her with the torpedo and blew her to atoms.

Under Water Warfare Considered Dishonorable

This experiment was made in the presence of the French admiral Villaret and a multitude of spectators. The committee of scientists to whom the submarine project had been referred were sceptical of its practicability and torpedoes were in those days considered a dishonorable method of waging war, so that both of Robert Fulton's ambitious projects came to naught. Had they been made use of, naval warfare might have been revolutionized over one hundred years ago.

Soon after the failure of his submarine boat Mr. Fulton returned to New York and began a series of experiments which resulted in 1807 in the *Clermont*, the world's first commercially successful steamboat.

German Ships Renamed.—The United States Shipping Board announces the new names of the five German sailing vessels on the Pacific coast which were taken over and are now in service under charters from the Shipping Board. The names selected are those of the famous clipper ships of the forties and fifties, vessels which long ago disappeared from the seas.

The *Steinbeck* has been renamed the *Northern Light*. The *Kurt* has been renamed the *Dreadnaught*. The *Dalbeck* has been renamed the *Red Jacket*. The *Vinner* has been renamed the *Game Cock*. The *Ottawa* has been renamed the *Flying Cloud*.

MARINE TERMINAL IMPROVEMENTS AT HOUSTON

New Wharves and Warehouses at Port of Houston, Texas

Fig. 1.—Water Side of Municipal Wharf No. 1

Fig. 2.—Railroad Connections to Municipal Wharf No. 4

Fig. 3.—Bird's-Eye View of Municipal Cotton Docks

Fig. 4.—Sea-Going Vessels Loading at Houston Municipal Wharves

Marine Terminal Improvements at Houston

New Municipal Wharves and Warehouses Built on Ship Channel at Houston, Tex., Fifty Miles from Gulf of Mexico

HOUSTON, TEX., the metropolis of the Southwest, is situated on the ship channel which connects the Port of Houston with the Gulf of Mexico through the Galveston Bay and Bolivar Roads. Its length is 50 miles with a minimum depth of 25 feet (terminating at the turning basin within the city limits). This great facility brings an enormous consuming territory 50 miles nearer to tidewater than other gulf ports. The turning basin is 1,100 feet wide on top, 980 feet on bottom and 26 feet deep. The channel is well marked with ranges and lights. All turns are figured on a minimum radius of 2,500 feet. Water in the upper channel is fresh. The channel has a land-locked harbor fronting both sides of more than 25 miles, safe and secure from storm, tides and overflows. The total cost of construction of the channel to date is $4,500,000 (£922,500).

Numerous large enterprises, some of them of national importance, are now located on the channel and others are making arrangements to take advantage of the industrial facilities provided by the ship channel and they are fast adding to the development of that splendid waterway. There has been marked activity during the past year, particularly, since the opening of the largest oil field in the south, which is located on the lower channel. Several large oil refineries are now under construction, besides other industries.

Construction of Marine Terminals

All marine terminals located at this port are municipally owned and controlled and are considered to be the finest and most substantial terminals in the United States, being constructed of reinforced concrete and all modern improvements.

Wharf No. 1 is now completed and in operation, being the first unit built. It is 650 feet long and has a concrete shed. The cubic capacity is 595,000 cubic feet. It has a square foot capacity of 94,550 feet, including apron, platforms and shed space.

Wharf No. 2 will be an open wharf and is now in course of construction. Its length is 504 feet. Its areal space will be 80,000 feet, which will cover shed space, if any shed is built on the wharf.

Wharf No. 3 will also be an open wharf connecting wharves Nos. 2 and 4. It is also under construction. This wharf will be 799 feet in length, having an areal space of 24,000 feet.

Wharf No. 4 is completed. It is 777 feet long, built of reinforced concrete, rat- and fireproof. The cubic foot capacity is 901,000 cubic feet and the areal space is 96,860 feet, including apron, platform and shed. Fig. 2 shows the track arrangement, also shed of the traveling conveyor for handling steel and machinery direct from ship to cars. The two uprights shown will be connected with a runway from the top of the shed to the retaining wall (across track) and connect with the new municipal storage warehouse.

The municipal cotton wharf and dock are now in operation and will accommodate 40,000 bales of cotton at one time. The height of the cotton wharf from the platform to the water surface is 28 feet.

Municipal Storage Warehouse

A modern concrete fireproof storage warehouse is now in course of construction and will be 400 feet wide by 600 feet long. This warehouse is being constructed right back of wharf No. 4 with all modern transportation facilities for safe and quick handling of freight. This warehouse, when completed including loading tracks, will cover six acres of ground.

RAILROAD CONNECTIONS WITH WHARVES

The Port of Houston is belted with municipal owned railroad tracks, storage and classification yards. All railroads entering this port have now or will be given an opportunity to make physical connection with the municipal belt.

The construction outlined briefly above is only the beginning of the extensive improvements which will be made at Houston. So far the terminals will cost within the neighborhood of $3,000,000 (£615,000). It is contemplated making Houston the largest industrial concentrating and distributing port of the Southwest.

Why Is A Pen?

A Dissertation by "Old Mac" on Ruling Pens, Lettering Pens and Various Accessories

"SAY, Mr. Mac, what is the matter with my ruling pen? It got dull and the more I sharpen it the worse it seems to be."

"How did you find out that it was dull?"

"It would no longer draw a fine line."

"Huh! let me see it. You certainly have it sharp, all right. Too sharp, and the leaves are not the same shape. One is longer than the other. Why don't you sharpen your wits and give the pen a chance? Keep it clean, hold it loosely and you will not have to touch it for a long time. Don't try to take a roughing cut off the edge of your triangle and curves and don't dig a ditch in the cloth. Don't make fine lines unless a very fine scale drawing absolutely demands it.

"However, you have put this pen on the bum, and the only thing to do now is to fix it. The first thing is to get the outline of the leaves right. If you had a large pen and you were drawing heavy, straight lines, a full leaf outline like this (Fig. 1) would be best, because you could lean the pen over through a greater angle and because it

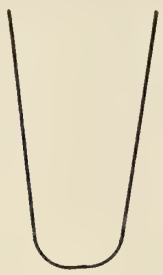


Fig. 1

Fig. 2

would hold more ink—you would not have to fill it so often. Your pen is small, and to get it easily around a sharp curve, a sharper outline like this (Fig. 2) will be best. A compass pen should have this outline and a small bow compass should have an even sharper outline.

"Now close the pen—not so tightly as to spring the leaves—and run it back and forth over a stone, holding it in a vertical position sideways and leaning it backwards and forwards. Don't grind off any more than is necessary to get the outline fair on both leaves. Now slack off on the screw. Take it out and open the leaves wide. Holding a leaf, point up, in the left hand rub down lightly with the stone in the right hand until the high light caused by the outline grinding has nearly disappeared. Do this over the whole outline, leaving the point a little dull.

"This is done for the reason that the ink, on account of its capillary attraction, will not work around a sharp edge and is therefore kept in the pen. Here is a section through the pen (Fig. 3).

"Resist the temptation to grind inside the leaves, because if it is done to any extent the point cannot be evenly and completely closed. There will be no burr to take off on the point if you leave it a little dull. If the stone leaves the surface a little scratched or rough, polish it by lighter rubbing or with oiled fine emery cloth. This polishing

Fig. 3

keeps the ink from spreading or drying on the outside of the pen.

"Put a little oil on the screw. A small soapstone or fiber washer under the head of the screw will ease it up, especially if the pen has a strong spring to the leaves or is a little rusty. A large head to an evenly turning screw is a great advantage because you can adjust the thickness of the line by eye and with the thumb and first finger of the right hand alone. You will become so expert after a little that you will not have to try a line on the edge of the cloth, but will guess it the first time.

"If the pen clogs a little, as it will on hot, dry days, squeeze the leaves together either between the thumb and first finger of the right hand or against the little finger of the left hand. This breaks the crust of dried ink and starts the free flow.

"Oftentimes a finer line has to be drawn next to a heavy line that has been made by drawing several lines, as an angle shown against a plate in section, for example. In drawing the heavy line, ink was carried up on the outside of the point. If a finer line is now to be drawn, the ink on the outside of the pen makes a bad line—thicker than the pen was set for and ragged.

"When the heavy line is finished and without shifting the left hand on the triangle, just touch the point of the pen with the little finger of the left hand, cleaning off the ink before it has dried hard and distributing it over the finger so thinly that it immediately dries and cannot soil the tracing. If the pen is clean outside, there is very little surface exposed for drying up the ink. You see some fellows run the pen all over the border of the cloth and scratch lines all over the back of their hands in an effort to keep the ink running when all that is necessary is a little cleaning on the outside of the point.

"There are a lot of different kinds of pens, but the plain 45-cent variety (in times of peace) is the best. Keep a rag handy, and if the ink dries up, clean it and use more ink. Ink is cheap, and especially now that we do not have

to buy it or mix it ourselves. If, after grinding, the pen feels too sharp and cuts the cloth, run it lightly over a stone to true up the leaves. You do not have to dig a ditch in the cloth, but merely start the ink to flowing and then move the pen along and let the ink trail out behind as if painting.

"Nearly always it is necessary to rub out, especially now that work is done on the cloth direct without pencil drawing. If you cut or scratch the cloth and then try to rub out, you will be in trouble. A lot of chalk rubbed on the cloth first helps in this way, also in that the ink dries quicker, does not penetrate into the fabric of the cloth and stays on top in a ridge that can be easily erased. The tracing does not wear as well, but lasts long enough. Don't run the pen so fast that the ink cannot flow out. The line will not be black and will be wavering and broken. Thin, fine lines are only excusable when rapid drying work is necessary and a good print or vandyke is not important.

"Remember that nowadays a tracing is made to convey information to the yard and as an office copy. It is not an advertisement of somebody's personality. Of course a draftsman has a certain amount of pride in his work, and neatness goes along with accurateness and carefulness, which are necessary; but remember that all these masterpieces that we sometimes try to make will be laughed at by the kids of a hundred years from now, just as we snicker at some of the funny yellow old shaded drawings with peculiar script printing that are now as out of style as wigs and knee breeches of the colonial days.

Lettering Pens

"What kind of a lettering pen have you? You can print with your ruling pen, you know. This is an advantage when the change to another pen would waste time. It is handy, but if you have much printing to do, a regular pen is better. Why do you kids always get a fine, sharp pen? It holds very little ink and scratches the cloth. It blots also if you are not very careful. Get a long-pointed stub, and after drawing the temper over a match flame, write with it on a stone, spreading the point and making eights or sixes, or writing up on a script tee until it is no longer sharp or rough.

"Old Man Higgins has a good scheme. He uses a ball-pointed pen in a flat penholder—flat, so that it will not

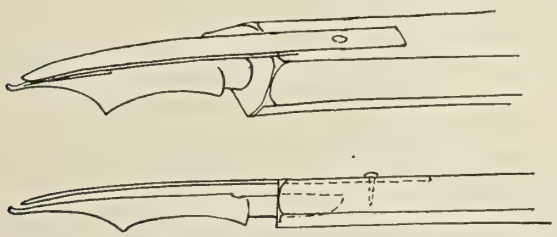


Fig. 4.—Old Man Higgins' Lettering Pen

turn in the hand. This holder is wood—Keuffel & Esser—10 cents (in times of peace), and the pen is a Lenard ball point, 506 F (there are other and finer sizes). He has taken a brass paper clip, straightened and flattened it out and fastened it to the back of the holder so that it projects down over the point of the pen and forms a pocket that can be filled with a relatively large quantity of ink.

"This fastening is a small, round-headed screw or a pin riveted through the holder. The spring of the projecting part is maintained by the part of the brass piece back of the pin or screw. The brass piece is turned at right angles to the holder and the back part bent down enough so that when it is turned back the projecting part is pressed against the point of the pen. A depression in the holder makes the clip line up and stay in line. You can load it up with a lot of ink and it will write black and heavy for a long while.

"Turning this pen on the side will cause it to write fine, making it suitable for small lettering in cramped places. It is cheap, will not blot and is the best all-around pen that I have seen. It don't scratch or cut the cloth, and lettering done with it can be easily erased. With the clip turned to the side it can be very easily cleaned. The old man has made about a dozen different styles of this pen. Get him to show you the latest improvement and how to handle it properly.

Eraser Holder

"Also get him to show you his new eraser holder. Like his pen it is home made, of wood. Two pieces hold the eraser in a slot and are wedged tight by a third wedge piece. He uses the ordinary ruby or emerald eraser, but the slot can be made to suit any size or shape of eraser.

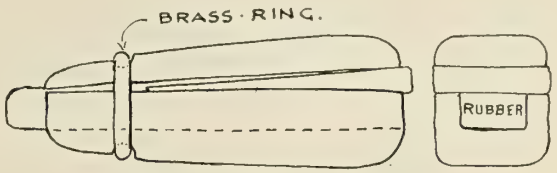


Fig. 5.—Convenient Eraser Holder

A brass ring that just slides over the nose of the holder when it is collapsed fits in a small groove and brings the pressure against the eraser when the wedge is pressed in the back. It will use up an eraser to the last quarter of an inch, and by only letting the eraser stick out a very little it is held firmly at the very edge, which is a great advantage in rubbing out against a shield. If ever you have much rubbing to do, such a holder will protect your hand wonderfully.

"He uses a fiber shield that he makes out of one of the stop cards in the index file (also home made). He claims that this is better than steel or German silver. Brass is dirty. Get him to show you the piece of glass he puts under the cloth when he has a particular job. He uses chalk under the cloth also. This holds the cloth from moving too much when pressure is great on the rubber and when it would otherwise roll up under the shield.

"While you are getting straightened out on pens, etc., and still have your lettering in the making, let me straighten you out on that also. You are not a natural letterer and you will have some hard work ahead of you. Use only an alphabet of vertical capitals, large and small, and do not use pencil guide lines. They are a waste of time and a crutch that you can easily learn to do without. If you do not use lines your printing automatically takes a size and spacing that makes it prominent and in proportion to the surrounding work. It is rapid because it takes time to draw the lines and they have to be rubbed out. Printing on lines is controlled by the lines and not by the surrounding work and is flat and monotonous. Get your style and don't change it. A No. 3 Pyzant pen is fine for titles. There are a couple of them around the office that you can borrow until you get a little flush and can buy one of your own. They make a large, clear, black rapid letter that dries readily. They don't blot.

"Go on over and cultivate Old Man Higgins."

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Care of Bearings

Perhaps one of the most frequent jobs that all engineers deal with is that of overhaul, adjustment, re-metalling, or refitting of bearings. This work on board ship involves a wide range of sizes, from the main shaft journals on down to the small brasses of the jacking or turning engine.

When a pound or knock is heard, the first thought is that some bearing has too much play or clearance, and you get busy to locate it. If the knock is an average one in sound, in the locating of it you must take plenty of time and be sure you are right when you note it down for adjustment at the end of the run. Many times a crosshead

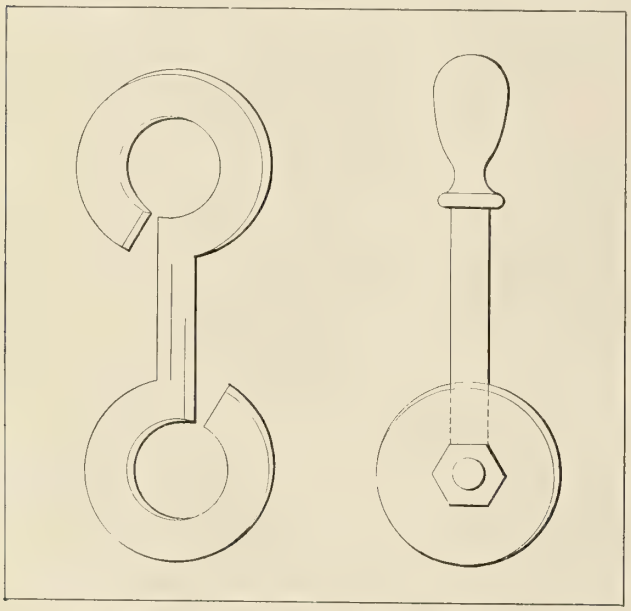


Fig. 1.—Scrapers for Refitting Large Bearings

brass is blamed for a knock that is in the line block of the nearby valve motion. Many main bearing caps have been unnecessarily refitted when the pound they were blamed for was in the crank next to them.

The easiest means of detecting the location of a knock is by flooding the suspected bearing with heavy oil and noting the change in sound. If the oil is consumed readily and cushions the journal, the sound is greatly softened and often stopped until the supply of oil has worked its way through, when, of course, the pounds will resume.

Very few slack bearings can be detected by the hand-feel method. This is true of large and small bearings alike. Many blower engine bearings have been burned up from keying up too tight when the knock was located by feeling out. High-speed engines should be dealt with patiently in finding the knock. After a pound has been located, the bearing nuts should be tried for slack. It is sometimes possible to get a little on each and eliminate the pound.

When necessary to reduce the clearance, before slacking the nuts, some definite means of marking their position should be used and these marks should be noted on a memorandum or other sure means of remembering them. After removing the cap and wiping the journal dry, a set of leads is taken (for babbit bearings, soft lead wire should always be used. Never use fuse wire, as it will cut into the babbit rather than compress, as it is very hard). The leads should be placed, the cap put back on and the nuts set up again to the marks. When setting up the nuts be sure to alternate, taking a little each time on the opposite nuts. Never take one side down more than the other. Many false leads have been made by improper care in fair setting up of the bolt strains.

Adjusting a Large Bearing

Having measured the thickness of each lead by wire gage, or micrometers, mark them on the bearing in pencil just where the lead lay in the cap, or draw a diagram of the cap and position of the leads. This gives you a record of the way your cap set before reducing the clearance. Assuming the clearance is too great, the next step will be to measure the liners or shims between the cap and lower half of bearing. If one of a few thousandths is among them, this can be removed and the next set of leads taken. It is generally found that the liners of large bearings are so assorted in thickness that there is always a thin .003 paper brass liner among them, but if not you will have to make such liners as will allow you to take out a few thousandths of an inch at a time, or as much as your set of leads show that you need to reduce the clearance. For example, say the bearing is a 14-inch main shaft; this requires 12 to 20 thousandths. You must reduce the liner thicknesses 6 thousandths.

It is generally found that some scraping is needed to relieve high spots or to give more clearance at the lips of the cap when a liner is removed. This work requires good tools and skill. Fig. 1 shows some scrapers that can be quite easily made and they will be found highly suitable for refitting large bearings. In removing metal for clearance by scraping always use a criss-cross stroke. Never confine your scraping strokes in any one or two directions and use extra care not to scrape too much from the ends of the cap, as this allows the oil to escape.

Having scraped and adjusted the bearing cap and removed the final set of leads, carefully blow out particles of dust with an air hose and wipe the liners off; then give the journal top a good coat of clean oil and assemble to the marks at which the last lead was taken. If each nut is set just a hair by the mark it insures the bearing cap being home.

Re-metalling or Babbiting

The first step is to melt out or chip out the old metal, then thoroughly to clean the parts to be re-metalled, also the melting pot and pouring ladles. There are several good ways to do this. If the bearings are small and removable they can be best cleaned by dipping them in the molten metal and leaving them there until the metal begins to sputter away from them. Another way is to heat them in a wood fire, pour some kerosene (paraffin) over them and let it burn off.

For cleaning the crucible and ladles sprinkle them well

with fine rosin and burn this off in the forge fire. Tinning the surfaces of a small bearing helps to hold the metal, but is not essential if proper means are used to anchor the babbit. If the bearing to be cast is one which has given previous trouble in loosened metal, cut the anchor holes or dovetails deeper or add more of them. Always cast the bearing on end, if possible, as shown in Fig. 2, and for damming up use fireclay and asbestos or asbestos wicking and putty. Loam clay, if available, is very good, the main point being to construct a rigid dam that will not give way when the metal is poured. Back the damming up with

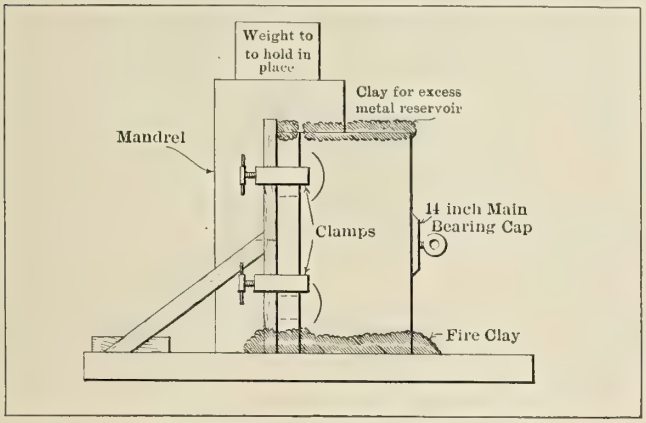


Fig. 2.—Method of Casting Bearing

strips of wood or packing, as shown in Fig. 2. Provide a riser, or excess metal trough, at the top to take care of the shrinkage.

Melting the Metal

Use a large size melting pot, one that will insure having plenty of metal to make the casting in one pour. Keep mixing or stirring the babbit while melting, dipping the ladle down to the bottom, bringing it up full and dumping it on the top of the pieces of melting babbit. Do not use too much old metal. Babbit metal which is used over too many times loses a large percentage of the tin and antimony each time it is re-melted, some being burned out. The dross or scum that floats on top of re-melted metal is the oxide formed by the combination of the metal with the oxygen of the air.

The work to be babbited should be very handy to the melting pot in order to retain the heat in the metal during pouring. Metal carried in a ladle any great distance is easily chilled and will not mold properly.

Heat the casting to be metaled to about half the heat of the melted babbit; never get the bearing too hot, as it will perhaps cause the liner to crack when cooled. The metal is ready to pour when a light pine stick held in the hot metal smokes or chars and transmits a trembling sensation to your hand. Skim off the dross when pouring, or before. Never completely empty a ladle when pouring. Hold back a little metal with which to dump out the dross.

The entire mold should be poured at once. To do this properly two ladles should be used and thus the stream of metal kept running. Any intermission in the pouring seldom joins well. Pour with care, slow at the start in order to see if the mold is tight at the base and to force out the air; then continue the pouring in a steady, fast stream. Continue until it overflows the riser, or excess metal reservoir. If there is room to puddle the metal while pouring it will pay well to do it. Use thin round iron rods and pump them up and down. This forces the air bubbles to the surface, also any impurities that may have flowed in the pouring.

After the cast has been made, if you desire a hard wearing surface, cool the mold at once with cold water, being careful to apply it gently to the shell and keeping it away from the molten metal. Apply it at the base first and slowly work upwards. This early cooling makes the metal much denser.

A good grade of babbit metal should always be used. The first cost may be somewhat high. High-grade tin babbit costs about one-half percent more than cheap babbit, but it pays bigger returns on the investment. If the bearing to be babbited is one that is to be bored out, the mandrel which is used should be much smaller to leave plenty of metal for boring. Such bearings should have the babbit additionally peened in to make it hard and denser. Use a round peen hammer and work from the center to the outer edge of the bearing. On the other hand, if the bearing to be cast is one that is to be scraped to fit, great care must be used to get the proper alinement of the mandrel. It must be the same size as the shaft, using just sufficient shims or liners to leave enough metal for scraping into a fit. The mandrel can be smeared with a thin coat of white lead if the bearing is of the small, solid type. When it is in two halves the liners should come close to the shaft, but have sufficient channel cut through them to have a free flow of metal to the lower half of the bearing shell.

Oil Grooves

A generous oil groove serves many purposes in a babbit-lined bearing.

1. A means of directing the distribution of the oil.
2. Providing a reservoir for oil.
3. A means of trapping the grit and dirt.
4. Affords a means of collecting the metal when a bearing slightly wipes from heating.

There are many approved ways for laying out the grooves. They should be deep, but not more than one-half the thickness of the lined metal. The edges should be

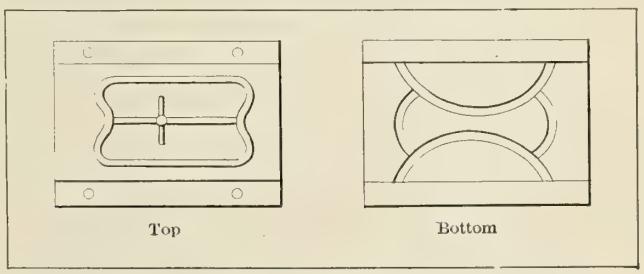


Fig. 3.—Layout of Oil Groves in Large Bearings

scraped rounding. A layout similar to that in Fig. 3 gives good results on large bearings.

For spiral grooving small bearings small-sized spring wire can be wound on the mandrel and coated with white lead. In winding start in the center and wind both right and left, stopping just short of the end. Oil grooves for small bearings are best cut by hand and with a curved round-nosed chisel, then finished with a scraper.

Concord, N. H. C. H. Willey.

Tight Pistons

Tight pistons and valves are, of course, absolutely essential—vital, in fact—to the economy of the reciprocating engine, and a piston that will remain tight in service and give the least trouble at the least expense is still a problem for the marine engineer.

Of course, when the cylinder is true and the piston a

good fit, excellent results are obtained with almost any design for a while, but this condition lasts only a short while. The cylinder and piston immediately begin to wear away from this ideal condition and two conditions rapidly develop that must be remedied. One is, steam leakage past the piston, and the other is the lateral motion of the piston knocking against the walls of the cylinder at the top and bottom of the stroke.

With floating piston rod packings, very commonly used of late years, the lateral motion of the piston is more difficult to take care of than formerly because the packing

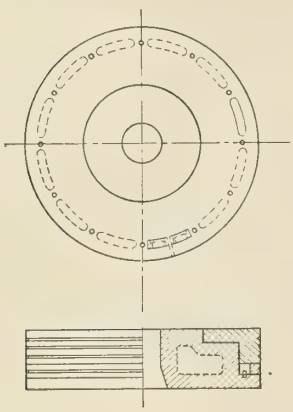


Fig. 1

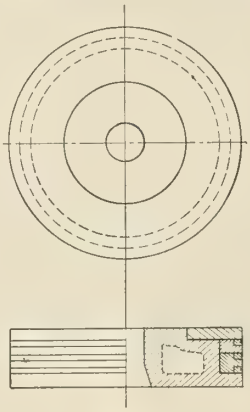


Fig. 2

in the stuffing box forms no bearing or guide for the rod.

Our high pressure cylinder, 23½ inches diameter by 42 inches stroke, was originally fitted with a deep follower and a single packing ring 1¼ inches square section. This ring was set up by springs reacting against the body of the piston. The expansion of the ring was limited by a link fitted over lugs cast inside the ring at the point where cut. The idea was that the ring being restrained in this way could not exert undue pressure on the walls of the cylinder and minimum wear would be the result.

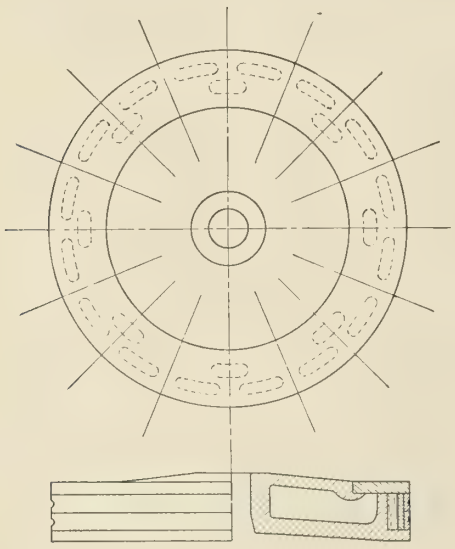


Fig. 3

The theory did not pan out, however. I have taken this ring out after a few days' wear and found it more than ⅛ inch smaller than the cylinder diameter. The original arrangement is shown in Fig. 1.

The inefficiency of the single restrained ring seemed clearly demonstrated by this time; also the follower and piston were appreciably worn, so a change was considered necessary. We turned out the edge of the deep follower and fitted the combination of bull rings and ramsbottom rings, as shown by Fig. 2.

This has been working satisfactorily for about two years, the spring rings lasting from three to five months (we run a little over 6,000 miles a month). In removing these snap rings, we are careful to caliper the cylinder and make the rings as thick radially as possible, completely filling the grooves provided for them in the bull rings. This takes care of the lateral motion of the piston.

Our intermediate pressure piston was fitted up originally the same as the original high pressure piston, Fig. 1. We changed the intermediate pressure piston later to a style similar to that shown in Fig. 2, only using two ramsbottom rings instead of three, as the space was too limited for three rings.

This was not so satisfactory as the high pressure piston, and we changed to the arrangement of Fig. 3. Here we found that if the springs were heavy enough to take care of the lateral motion of the piston, there was too much pressure on the rings, so we removed four rings and substituted neatly fitting cast iron radial blocks. These blocks hold the piston central, provide against any lateral movement and relieve the springs of any duty except to keep the packing rings set out against the walls of the cylinder.

While the piston arrangements described here are far from perfect, we have found them very satisfactory as improvements over the original designs, and hope they may be of interest to some one else having piston troubles.

Norfolk, Va. "X."

Economy Paragraphs

Provide your men with helpful information as to performance of their duties; do something for their personal comforts, both on and off watch.

Repair tools. A well-stocked tool locker with the best of tools saves time in emergencies—that's economy.

Sheet packing should be cut to templates with a sharp knife. Tons of packing are wasted by the crude method of cutting it on the flanges with a ball-peen hammer. It is only justifiable to use that method when saving time is urgent.

Do not burn the used waste; save and wash it—it can be used many times. W.

BOOK REVIEW

FRANK WATERHOUSE & COMPANY'S PACIFIC PORTS. Third edition. Edited by Welford Beaton. Size, 5 by 7½ inches. Pages, 350. Seattle, Wash.: 1917. The Terminal Publishing Company. Price, $3.00 net.

At a time when the attention of America is occupied so largely with foreign trade, this volume will prove a valuable addition to commercial literature, and any commercial house that is doing business on the Pacific Coast, or with any of the countries or islands of the Pacific, cannot very well afford to be without it. It is a commercial geography, a commercial dictionary, a transportation guide and a marine manual in one volume; attractively bound in limp leather and most carefully compiled for ready reference. A marine section, covering nearly 40 pages, contains excerpts from quarantine laws and regulations in force in the principal ports on the Pacific Coast and much other miscellaneous information that it is necessary for shipmasters and owners to have. Shipbuilding and ship repair companies and dry docks and marine railways are listed alphabetically.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Relieving Excess Pressure in Boilers

Q. (892).—How should the water in the boiler be changed while steam is up if the safety valve was stuck? How would the pressure on the boiler be relieved if the steam was up and could not make its escape?

A. (892).—It is difficult to surmise the exact point of your query. If the second part means what would happen if no outlet was opened from the boiler and steam continued to be generated, the answer is that the pressure would increase until ultimately it reached a point when explosion of the boiler would occur. If the first part means what should be done in an emergency when the safety valve is stuck and the main stop-valve cannot be opened, the answer is, draw fires.

Receiver Pressures in Compound or Triple Expansion Marine Engines

Q. (882).—How are the receiver pressures determined in a compound or triple expansion marine engine, so that each cylinder is doing an equal amount of work? Does this have to be done with indicator cards? Please give an example showing how it is done: engines, high pressure, 27½ inches; intermediate pressure, 34½ inches; low pressure, 50 inches diameter; stroke, 36 inches; working pressure, 185 pounds per square inch. Engine designed to develop 1,600 horsepower.

A. (882).—The receiver pressures in an engine already built are controlled by the valve settings for the various cylinders, and while the hypothetical pressures to give equal work in each cylinder may be predicted, they are not good criterions by which to judge the engine condition. The best information as to adjustment of an engine for either maximum output or maximum economy of steam is that given by Prof. Wrighton's † investigation of best cut-off.

This states that for maximum *economy* cut-off should occur as follows:

$$\text{Cut-off for maximum economy} = 0.15 + \frac{1}{R} \text{ when } R \text{ is}$$

the ratio of capacities of the cylinder under discussion to the preceding cylinder.

Cut-off for maximum power

$$\text{Intermediate-pressure cylinder} = 1.4\left(0.15 + \frac{1}{R}\right)$$

$$\text{Low-pressure cylinder} = \left(0.15 + \frac{1}{R}\right)$$

same as for maximum economy.

For your case this would mean that for maximum economy you should operate with the cut-offs for intermediate at

$$0.15 + \left(\frac{27.5}{34.5}\right)^2 = 79 \text{ percent of stroke,}$$

and for low at

$$0.15 + \left(\frac{34.5}{50.0}\right)^2 = 63 \text{ percent of stroke.}$$

For maximum power you should operate at cut-offs, for intermediate as late as gear will permit, and for low the same as for maximum economy (63 percent).

Annealing of Welded Bronze Propeller Wheels

Q. (895).—Will you kindly furnish an opinion on a question about which there is a difference of opinion? The circumstances of the case are as follows: A bronze four-bladed solid propeller of about 15 feet diameter had one of its blades broken off about one-third of its length and a new part was cast of the same bronze, which was welded on by the acetylene process. The wheel was put in service and after several trips the same blade broke off, not, however, in the weld, but about 6 inches beyond the weld toward the end of the blade. When welding this blade the first time, the heat was applied only along the welded portion about 6 to 8 inches each side of the weld. The blades are about 3 feet wide and the center section about 3 inches thick.

A second weld was made in a different manner. A mold was made of the opposite blade and the new cast piece of blade was made out of the same bronze material and laid with the broken blade in the mold, after both the broken end and the end of the new cast piece had been prepared for welding. The whole blade was heated to a uniform heat while welding.

Several English marine engineers contend that the first welded blade broke because the whole propeller was not annealed, and that the second welded piece will also break off if the whole wheel is not annealed as they do in England. The writer and several American engineers who have had experience in bronze mixtures and bronze wheels have never heard of bronze wheels being annealed, and therefore would appreciate your opinion regarding this matter.

A. (895).—It is not the custom in this country to anneal bronze propellers, and I have never heard of it being considered necessary. The failures occurring as you mention are more likely attributable to faulty material or improper design in not allowing sufficient thickness of blade to withstand the stress. Some yards make slight repairs to bronze propellers by welding in patches by the oxy-acetylene process. If the designed thickness is sufficient, the repair as given in your second method should be good without annealing the whole wheel. The blade failed at about the point where calculations usually show the greatest stress, and this leads to the suspicion that the original design may have been faulty.

Boiler Horsepower

Q. (890).—A boiler evaporates 28,930 pounds of feed water from a temperature of 127 degrees into steam at 85 pounds pressure during a run of ten hours. What horsepower is developed by the boiler?

A. (890).—One boiler horsepower is defined as the "evaporation of 34.5 pounds of water per hour from and at 212 degrees F.," which is equivalent to 33,479 B. T. U.'s or 33,455 B. T. U.'s, according to whether we use the heat of vaporization at 212 degrees of 970.4 B. T. U.'s as given by Mark's and Davis' Tables or 969.7 B. T. U.'s as given by Peabody. To raise one pound of water from 127 degrees F. to 316.3 degrees F., which is the boiling temperature corresponding to 85 pounds (absolute) requires q 316.3° — q 127°, or 286.5 — 95 = 191.5 B. T. U.'s. To vaporize one pound at this pressure into dry steam requires the latent heat or heat of vaporization of 896.6 B. T. U.'s, so that the total heat spent on the feed water to get it into

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* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

† "Receiver Drop in Multiple Expansion Engines." N. E. Coast Institute of Engineers and Shipbuilders, Vol. XVI.

steam at 85 pounds (absolute) is 191.5 + 897 = 1,088.5 B. T. U.'s. The boiler produces 2,893 pounds of steam per hour, which is equivalent to 2,893 × 1,088.1 = 3,149,000 B. T. U.'s. This corresponds to a boiler horsepower of 3,149,000 ÷ 33,479 = 94.

Another and shorter way of doing this same problem is to make use of a table of "factors of evaporation" as given in most hand books which converts the *actual* evaporation into *equivalent* evaporation from and at 212 degrees by a single multiplication. From such a table ("Steam," Babcock & Wilcox Company) the factor for the above condition of 127 degrees feed and 85 pounds absolute pressure is 1.1216, so that the equivalent evaporation is

$$\frac{28930}{10} \times 1.1216 = 3243 \text{ pounds per hour,}$$

and the boiler horsepower is 3,243 ÷ 34.5 = 94.

Constants for Horsepower

Q. (894).—Will you kindly tell me (a) how to find constants for horsepower for an engine 22 by 37 by 60 inches by 42 inches stroke and how to apply it with varying piston speeds and steam pressures? Please supply the necessary data besides size of engine. Also (b) if a ship makes 18 miles (15.63 knots) at 100 revolutions per minute with 25 percent slip, what distance will she make with 125 revolutions and 20 percent slip?

A. (894).—(a) The general expression for indicated horsepower is

$$\frac{2PLAN}{33{,}000},$$

where P = mean effective pressure (pounds per square inch),
L = length of stroke in feet,
A = area of piston in square inches (net),
N = number of revolutions per minute.

Assume 6-inch diameter piston rods for all cylinders and no tail rods (area 6-inch rod = 28 square inches).

For any given cylinder the only items which can vary in the above expression are P and N, so the engine constant becomes:

$$C = \frac{2LA}{33{,}000}, \text{ and then } I.H.P. = C \times P \times N,$$

$$C_{\text{high}} = \frac{2 \times 3.5 \left(380 - \frac{28}{2}\right)}{33{,}000} = .0777.$$

$$C_{\text{int}} = \frac{2 \times 3.5 \left(1075 - \frac{28}{2}\right)}{33{,}000} = .225.$$

$$C_{\text{low}} = \frac{2 \times 3.5 \left(2827 - \frac{28}{2}\right)}{33{,}000} = .597.$$

These constants multiplied by the average of the top and bottom mean effective pressures and by the revolutions per minute will give the indicated horsepower for the individual cylinders. The area used is the average of the top and bottom areas (the top area minus one-half rod area for this case) and if more refinement were desired a constant for each end could be worked out, using the actual area of that end and omitting the factor 2. Then the mean effective pressure of each end of each cylinder would be multiplied by the constant for that end and all summed to get the total indicated horsepower. It is rarely, however, that the accuracy of the indicator diagrams warrants this refinement, and the constants as derived above serve all practical needs. To make the problem complete, assume the following mean effective pressures to have been worked up from the cards averaging those for the top and bottom ends of each cylinder:

M. E. P., High = 70 pounds per square inch,
Int. = 38 pounds per square inch,
Low = 14 pounds per square inch,
R. P. M. = 75.

Then *I. H. P.*, High	= .0777	× 80	× 75 =	466
Int.	= .225	× 35	× 75 =	590
Low	= .597	× 13.5	× 75 =	604
			Total I. H. P. =	1660

(b) The expression for apparent slip is

$$S = \frac{PR - 101.3V}{PR}$$

where S is apparent slip expressed decimally,
P is pitch of the propeller in feet,
R is revolutions per minute of the propeller,
V is speed of the ship in knots.

From this the pitch is

$$0.25 = \frac{P \times 100 - 101.3 \times 15.63}{P \times 100},$$

$$P = 21.1$$

Using the above pitch the *speed* at 125 revolutions per minute and 20 percent apparent slip will be

$$0.20 = \frac{21.1 \times 125 - 101.3V}{21.1 \times 125},$$

$$V = 20.8 \text{ knots.}$$

It should be noted that the data given are impossible the increase of revolutions per minute is accompanied by a decrease in apparent slip when actually it is always accompanied by an increase in apparent slip.

Heat Transfer in Oil Cooler

Q. (878).—Will you please give us some assistance in settling the following point which has come up in testing an oil cooler? In finding the B. T. U. transmitted per square foot, per degree difference of temperature, it is necessary to divide the total B. T. U. transmitted by the heating surface and by the *mean* temperature difference.

Gebhardt, "Steam Power Plant Engineering," page 563, gives the following formula for mean temperature difference:

$$\text{Mean temperature difference} = \frac{t - t'}{LOGe \frac{t}{t'}}$$

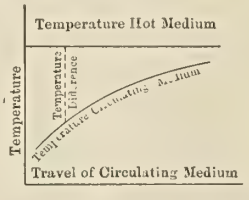
in which t is the original temperature difference and t' the final temperature difference of the two fluids.

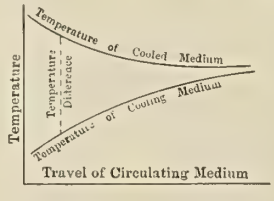
In one of our runs we had the following observations:

Inlet temperature oil	120.4 degrees F.
Outlet temperature oil	107.0 degrees F.
Inlet temperature cooling water	79.6 degrees F.
Outlet temperature cooling water	93.1 degrees F.

As this is a counter-current cooler, the original temperature difference $= t = 120.4$ degrees $- 93.1$ degrees $= 27.3$ degrees, and final temperature $= t' = 107.0$ degrees $- 79.6$ degrees $= 27.4$ degrees. In other words, the initial and final temperature differences are about the same, and when we substitute these values in the formula for mean temperature difference, we get an absurd value.

A. (878).—As long as the amount of heat transferred per square foot of surface is considered to be directly pro-





portional to the difference of temperature existing on the two sides of the surface the expression given for mean temperature difference is correct for any sort of heat transfer apparatus.

When T_1 and T_2 are nearly equal, though, this expression becomes unstable, and when $T_1 = T_2$ it is indeterminate. The mean temperature difference for these cases is, then, best determined by taking the arithmetic mean.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

American Shipbuilding Doubled in a Year

According to figures submitted to the United States Senate on June 1 by Vice-Chairman Brent of the United States Shipping Board, the total merchant construction in American shipyards, including completed and undelivered vessels under contract, for all persons, corporations or governments other than the United States, on May 1, 1917, was 537 steel ships, aggregating 2,039,261 tons, and 167 wooden ships, aggregating 214,753 tons. On May 1, 1916, the construction in American shipyards included 368 steel ships, totaling 1,129,014 gross tons. Wooden ships were not reported.

These figures show an increase in total steel construction on hand of nearly 100 percent over that of the corresponding date a year ago. The total increase in the amount of work on hand since January 1 of this year is nearly 600,000 tons.

Shipbuilding Contracts Let by Shipping Board Corporation

The United States Shipping Board Emergency Fleet Corporation, Washington, D. C., has announced the following contracts, in addition to those mentioned in our last issue:

Sloan Shipyards Corporation, Seattle Wash.—Sixteen wooden cargo carrying steamers complete; first steamer to be delivered January 31, 1918; two in February, 1918; four in March, 1918; two in April, 1918; two in May, 1918; two in June, 1918; two in July, 1918.

Gray's Harbor Motor Ship Corporation, Aberdeen, Wash.—four wooden hulls; first hull to be delivered January 15, 1918; second, February 15, 1918; third, March 15, 1918; fourth, April 15, 1918.

Coast Shipbuilding Company, Portland, Ore.—Four wooden hulls; first hull to be delivered January 1, 1918; second, March 1, 1918; third, May 1, 1918; fourth, July 1, 1918.

Edward F. Terry & Henry L. Brittain, 60 Broadway, New York City—Works, Moss Point, Miss.—Twenty composite cargo carrying steamers complete; first steamer to be delivered February 1, 1918, and the remaining 19 within next ten months.

Skinner & Eddy Corporation, Seattle, Wash.—Six steel cargo carying steamers complete; first two steamers to be delivered within five months from date of arrival of keel plates, and of the remaining number of steamers the building of the second two steamers shall be commenced immediately after the completion of the first two steamers, and shall be delivered within five months after the laying of the keels, and the building of the remaining two steamers shall be commenced immediately after the completion of the second two steamers, and shall be delivered within five months after the laying of the keels.

Sanderson & Porter, 52 William street, New York City—Works, Willapa Harbor.—Ten (10) wooden hulls; first hull to be delivered on April 1, 1918, and one hull every fifteen (15) days thereafter, ending August 30, 1918.

The Maryland Ship Building Company, Lexington building, Baltimore, Md.—Works, Sollars Point, Md.—Six (6) wooden hulls; first hull to be delivered April 30, 1918, and one hull to be delivered on the last day of each succeeding month, ending September 30, 1918.

The Seattle Construction & Dry Dock Company, Seattle, Wash.—Ten steel steamships; first and second to be delivered in June, 1918, and thereafter at intervals until the tenth ship is delivered in December, 1918.

The Foundation Company, 233 Broadway, New York.—Ten wooden hulls; the first to be delivered March 6, 1918, and one every fifteen days thereafter.

The Groton Iron Works, Noank, Conn.—Twelve wooden hulls; the first hull to be delivered in five months after receipt of lumber for keels and one hull every fortnight thereafter.

The Ship Construction & Trading Company, Stonington, Conn.—Two wooden hulls; one to be completed February, 1918, and one March, 1918.

The Traylor Shipbuilding Company (a subsidiary of the Traylor Engineering & Manufacturing Company, Allentown, Pa.)—Ten wooden vessels; the first to be delivered in January, 1918, and one each month thereafter.

Summary to date (June 18):

Total number of contracts executed	16
Total number of ships and hulls contracted for	138
Complete steel ships	28
Complete composite ships	32
Complete wooden ships	30
Total complete ships	90
Wooden hulls	48

Wooden Shipbuilders of the Northwest Organize

In order to insure that the State of Washington shall secure her share of the wooden shipbuilding contracts to be made by the United States Shipping Board, a number of wooden shipbuilders of the Puget Sound and Gray's Harbor district have completed preliminary plans for organizing the Wooden Shipbuilders' Association of the North Pacific.

It is proposed by the wooden shipbuilders to organize a commissary department for the purchase of supplies for the different yards, and that the lumbermen be requested to have a committee meet with the shipbuilders that they may co-operate in an effort to get the best results.

Patrol Ship Inspection

George Uhler, Supervising Inspector-General, Steamboat Inspection Service, of the Department of Commerce, has sent the following instructions to United States supervising, local and assistant inspectors:

"As it is probable that requests will be received by you from the special board for patrol vessels for the examination of vessels suitable for this purpose, you are directed to co-operate at once, upon receipt of such requests, to the fullest extent in this work.

"At this critical time results are desired, and therefore there must be no delay in your hearty co-operation."

Shipbuilding Contracts

The McMyler Interstate Company has received a contract from the Navy Department for furnishing shipbuilding frames at the Puget Sound Navy Yard at a cost of $230,727.

The Seattle Machine Works, Seattle, Wash., has received a contract from the Skinner & Eddy Shipbuilding Corporation for two sets of triple-expansion engines of 2,700 horsepower each.

The Mathews Shipbuilding Company, Hoquiam, Wash., has received a contract from the E. K. Wood Lumber Company, San Francisco, Cal., to build a twin-screw wooden motor ship 170 feet long.

It is reported that the Union Bridge & Construction Company, Kansas City, Mo., will build ten ships for the Shipping Board at its new yard to be constructed at Morgan City, La.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Savannah Line, Pier 35, North River, New York, for a duplicate of the *City of St. Louis*, the flagship of the Savannah Line's fleet. Delivery is to be made in twenty months.

To J. W. Norcross, vice-president and managing director of the Canada Steamship Lines, Ltd., Montreal, Canada, has been delegated by the Canadian Government the work of having built in Canada 36 steel steam trawlers and 100 wooden steam drifters.

It is officially announced that the Bethlehem Steel Corporation, South Bethlehem, Pa., has about 135 steel vessels under construction or under contract at its various shipbuilding plants.

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A Battleship on Shore—U. S. S. *Recruit*, Naval Recruiting Station in Union Square, New York City

Boys Under 17 Not to Be Enlisted in Naval Service

Secretary of the Navy Daniels has issued the following order:

"Inasmuch as the rate at which recruits are being obtained is satisfactory, and as it is undesirable at present to take into the naval service young boys, whose education is not completed, it is directed that until further orders no enlistments in the Navy or Marine Corps, or enlistments in the Naval Reserve Force or Marine Corps Reserve, be made of boys less than 17 years of age."

Nomination of Midshipmen to the U. S. Naval Academy

The Navy Department authorizes the following: The first nominations are coming in for the increase of 531 'midshipmen at the United States Naval Academy. Congress passed an act on April 25 providing an additional appointment for each Senator, Representative and Delegate, and the candidates will soon be designated for the examinations, which are to be held at civil service examination points throughout the country on June 27.

After the mental examinations are completed ,the papers will be sent to the academy to be marked and graded, and those who have passed will be given the physical examination at Annapolis.

There are now in the academy 940 'midshipmen. The 183 in the class graduated on March 29 would, in the ordinary course, be commissioned as ensigns July 1. They are now in the service, and a bill has passed the House and has been favorably reported to the Senate to commission them as ensigns at once. Another class of 202 will be graduated early in September.

To accommodate the large increase in the number of 'midshipmen at the academy, temporary quarters are being built. About 1,250 can be accommodated in the present building, and with the addition of the new quarters there will be provision for between 1,500 and 1,600.

Herreshoff Manufacturing Company Re-Organized

The Herreshoff Manufacturing Company, Bristol, R. I., famous for the design and construction of American cup defenders and other racing yachts, was recently reorganized and the following officers elected: President, N. H. Herreshoff, Bristol, R. I.; vice-president, A. Loring Swasey, Taunton, Mass.; treasurer, Robert W. Emmons, 2d, Boston, Mass.; secretary, C. W. Young, Bristol, R. I.; general manager, James Swan, Bristol, R. I.

The directors are N. H. Herreshoff, James Swan, A. Loring Swasey, R. W. Emmons, 2d, George Nichols, New York City; C. F. Adams, Boston, Mass.; H. P. Whitney, New York; I. Lewis Stackpole, Boston, Mass., and I. MacDowell Garfield, Boston, Mass.

The Herreshoff Manufacturing Company now has a very large amount of work under contract, including three steel patrol boats, 110 feet in length, of 1,200 horsepower, with oil-burning watertube boilers; also two 80-foot wooden patrol boats, burning oil fuel, and ten 62-foot patrol boats with gasoline engines. The company has recently completed the 114-foot steam yacht *Navette* for J. P. Morgan, which on a trial course of 16 nautical miles showed a speed of 20.6 knots, this being 1.6 knots in excess of contract requirements. The company has also completed the 58-foot motor yacht *Lady Gay* for Mrs. J. P. Lippincott, Philadelphia, Pa.

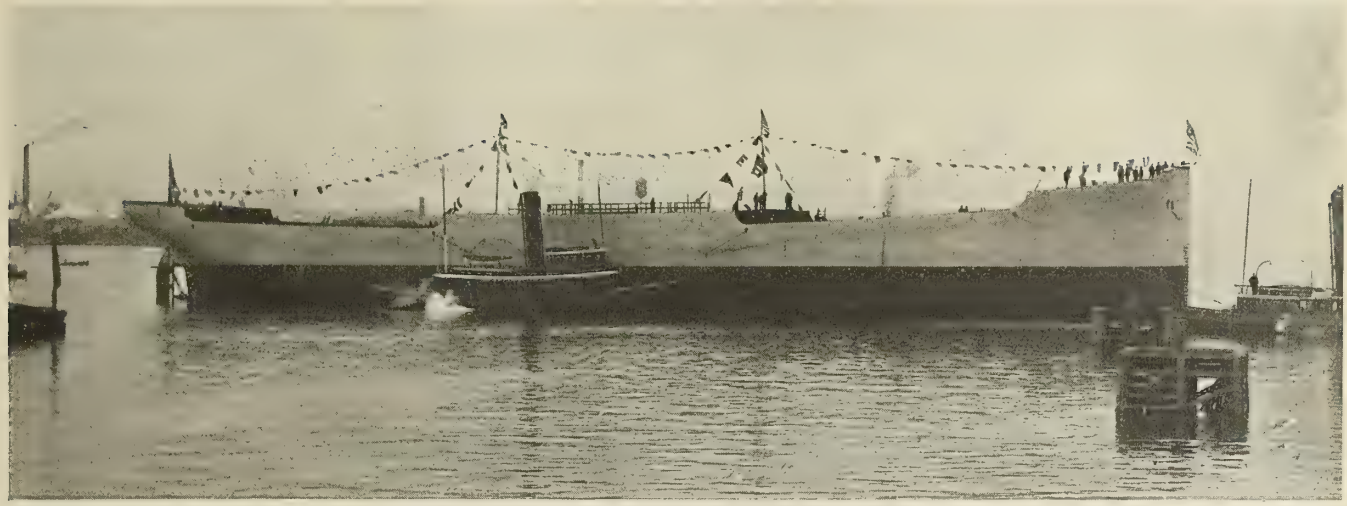
Recent Launchings

The 11,000-ton oil tanker *Pennsylvania* (June 9), building for the Texas Company, New York, at the Fore River Shipbuilding Corporation, Quincy, Mass.

The 240-foot steam yacht *Isabel*, for John N. Willys, president of the Willys-Overland Company, building by the Bath Iron Works, Ltd., Bath, Me., in accordance with designs by Cox & Stevens, naval architects, New York. This vessel was taken over by the Government in May.

A 230-ton schooner (May 22), building by Sidney Jones, of Weymouth, Nova Scotia, for the Standard Oil Company.

The 14,900-ton Isherwood framed oil tanker *W. C. Teagle* (June 9), building for the Standard Oil Company of New



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Launching of S. S. *Scandanavic* at Shooters Island Yard of Standard Shipbuilding Company, New York, on May 29

Jersey by the Bethlehem Steel Company, Maryland Plant, Sparrows Point, Md.

The oil tanker *William Isom*, of 5,000 tons deadweight capacity, building for the Sinclair Gulf Corporation by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.

The sea-going barge *Glenside* (June 9), building for the Reading Transportation Company, Philadelphia, by the Coastwise Shipbuilding Company, Baltimore, Md.

A 100-foot open lighter (June 9), building for the Maryland Transportation Company by Chas. Rhode & Sons Company, Baltimore.

The cargo steamship *Scandinavic*, of 7,300 tons deadweight

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Last of Passengers Leaving the French Liner *Sontay*, Torpedoed by a U-Boat in the Mediterranean on April 10. The Vessel Sank in 4 Minutes. Forty-five Persons, Including the Commander, Were Lost

carrying capacity (May 29), building by the Standard Shipbuilding Corporation, New York, at their plant on Shooters Island, for the Atlantic Transportation Company, Gothenburg, Sweden.

Shipyard News

The South Jersey Shipbuilding Company, Camden, N. J., has been incorporated, with a capital of $125,000, to establish a shipbuilding plant at Leesburg, on the Maurice River. The company is said to have acquired waterfront property at this location for the proposed works, which will be equipped to specialize in the manufacture of vessels of wooden type for coast service. The incorporators of the company are Howard Compton, Leesburg; Albert D. Cummins, 207 Westmont avenue, Haddonfield; Harlan E. Goodell, 1123 Walnut street, Philadelphia, Pa., and Walter R. Sparks, 1867 Wynnewood Road, Philadelphia.

The Harlan & Hollingsworth Corporation, Wilmington, Del., will build a new pipe and rigger shop addition to its shipbuilding plant, about 80 by 112 feet. Two other structures will also be erected, each one story, 20 by 80 feet, and 30 by 50 feet, respectively.

The Sun Shipbuilding Company, Chester, Pa., has awarded a contract for the erection of a one-story addition to its works, about 50 by 110 feet.

The R. G. Packard Company, Twenty-eighth street, Bayonne, N. J., manufacturer of dredging machinery, is said to be planning for the early construction of its proposed new shipbuilding plant on property recently acquired on the Raritan River near Perth Amboy.

The Fernandina Shipbuilding & Dry Dock Company, Dover, Del., has been incorporated, with a capital of $1,000,000, to build and operate a plant for the construction of vessels of different types. F. D. Buck, M. L. Horty and K. E. Longfield, Wilmington, Del., are the incorporators.

The Maryland Shipbuilding Company, Lexington building, Baltimore, Md., is arranging preliminary plans for the erection of a new shipbuilding plant near Bear Creek. The proposed plant is estimated to cost about $750,000. C. E. F. Clark is president of the company.

The Pusey & Jones Company, Wilmington, Del., has commenced the erection of additions to its plant to cost about $200,000. The company has expended a total of about $1,000,000 in plant extensions during the past year.

The New York Dry Dock Ship Construction Company, New York City, has recently been incorporated in Delaware, with a capital of $12,500,000, to build and operate a large plant for ship construction. Arthur W. Britton, Harry B. Davis and Samuel B. Howard, all of New York, are the incorporators.

The York River Shipbuilding Company, Port Richmond, Va., is considering the erection of a new shipbuilding plant on the Mattaponi River. Plans for the works are now being prepared. This company was recently incorporated, with a capital of $1,000,000. Warner Moore is president.

The Staten Island Shipbuilding Company, Mariners Harbor, Staten Island, N. Y., has filed plans for the erection of a new extension to its plant at Port Richmond to cost about $40,000. A new foundry building will also be erected at a cost of about $25,000.

The Submarine Boat Company, Bayonne, N. J., recently organized as a subsidiary of the Elco Company, Avenue A, Bayonne, manufacturer of motor boats and marine engines, has leased property consisting of about 110 acres at Avenue R, on the Newark meadows, Newark, N. J., as a site for a new plant for the construction of undersea craft and submarine chasers. The company is also planning to use a portion of the Elco plant at Bayonne for the manufacture of similar vessels, and is said to be considering extensions to the works. Henry R. Sutphen is vice-president.

The Newburgh Shipbuilding Company, Newburgh, N. Y., has been acquired by the Newburgh Shipyards, Inc., recently incorporated, with a capital of $3,000,000. The new company plans for the construction of additions to the present plant which is now in course of erection at an estimated cost of $200,000. Thomas C. Desmond, Bush Terminal building, Brooklyn, and John F. Farrell, South Norwalk, Conn., are heads of the company.

The Chester Shipbuilding Company, Chester, Pa., has been acquired by new interests, which plan to increase the capacity of the plant by the construction of four new shipbuilding slips, allowing the construction of twelve vessels at one time. The new organization is said to have acquired property at Bristol, Pa., fronting on the Delaware River, and plans for the construction of a new plant to be operated in conjunction with the Chester work. C. W. Hamilton is president; C. P. M. Jack, Swarthmore, is general manager.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has awarded a contract to James Stewart & Company, New York, for the erection of the proposed four-story addition to its plant. The structure will be about 50 by 250 feet.

The Transatlantic Shipbuilding & Lumber Construction Company, capitalized at $2,500,000, has been organized at Portland, Me., for the construction and operation of ships constructed of wood, steel and other materials. T. L. Croteau, of Portland, is president and A. B. Farnham, of Portland, is treasurer.

The Portland Ship Ceiling Company, Portland, Me., is building a new shipbuilding plant at East Deering.

The Meacham & Babcock Shipbuilding Company, recently incorporated in Seattle, Wash., is constructing four shipbuilding ways at Ballard, Wash., and eventually expects to have twelve ways available.

The Beaumont Shipbuilding & Dry Dock Company, Beaumont, Tex., has purchased a 66-acre island park property from the city of Beaumont, where it is now constructing a wooden shipbuilding plant, provision being made for eight building ways.

Christoffer Hannevig, Inc., 120 Broadway, New York, is head of the Newfoundland Shipbuilding Company, which is understood to have decided upon Harbor Grace for a site. According to report, several million dollars will be spent in equipping the plant, which will first turn out wooden vessels and later steel ships.

The Gulf Shipbuilding Company has been organized at Millville, Fla., with the intention of building wooden ships.

The Bagdad Shipbuilding Company has been organized at Bagdad, Fla., and plans to establish a yard to build wooden vessels.

The Trenton Shipbuilding Company, 15 Exchange Place, Jersey City, N. J., has been incorporated, with a capital stock of $500,000.

The Sunlight Building & Oil Company, Philadelphia, Pa., is reported to have acquired about 200 acres of land, with the intention of building a shipyard.

The Traylor Engineering & Manufacturing Company, Allentown, Pa., has acquired a tract of land on the Delaware River and is planning to build a shipyard.

Work has been started on the plant of the Tacoma Ship Company, Tacoma, Wash.

The G. M. Standifer Construction Company has been incorporated, with headquarters in Portland, Ore., and will erect a wooden shipbuilding yard.

The Florence Shipbuilding Company has been organized, with a yard in Florence, Ore. J. Fred Larsen, Portland, Ore., is the principal owner.

Sommarstrom Bros., of Oakland, Cal., are reported to be preparing plans for a shipyard at Columbia City, Ore.

Louis Paquet and Charles S. Miller, Kelso, Wash., are reported to have let contracts for a wooden shipbuilding plant.

Janes Bros. and Boomer, Crane & Howe, of Morgan City, La., have leased land for a wooden shipyard to be built on Berwick Bay.

The National Shipbuilding & Dry Dock Company has been incorporated by E. D. Flynn, John A. Calhoun and others, and will establish a shipyard at Savannah, Ga.

The Star Shipyards, New Orleans, La., have been incorporated by Walter Cook Keenan, H. M. Feild and Crawford Ellis, all of Louisiana. It is understood that the new company will establish a shipyard at Lake Ponchartrain, and that contracts have already been received to build six wooden ships.

The L. M. Dantzler Lumber Company, Moss Point, Miss., has announced that it will build a yard for the purpose of constructing wooden ships.

The American Shipbuilding Company has been organized in Brunswick, Ga., by the American Tie & Timber Company. The new company is reported to have received contracts to build several ships.

The Gulfport Shipbuilding Company, Gulfport, Miss., has been incorporated by Rapp Reynolds, R. Quinn, W. J. Faust and E. T. Childs.

Horton & Horton, Houston, Tex., will build a shipyard.

The Midland Contracting Company, Houston, Tex., has acquired a site of land and is planning to build wooden vessels.

The Carter Lumber & Building Company, Houston, Tex., has acquired a site and is planning to build wooden ships.

J. J. Stattegast, Jr., president of the Houston Car Wheel Works, Houston, Tex., is planning to build wooden ships.

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S. S. *Manchuria* Damaged by Collision with U. S. Monitor *Amphitrite* in Dense Fog in New York Bay on Night of June 13. Holes in Starboard Side Flooded After Compartments

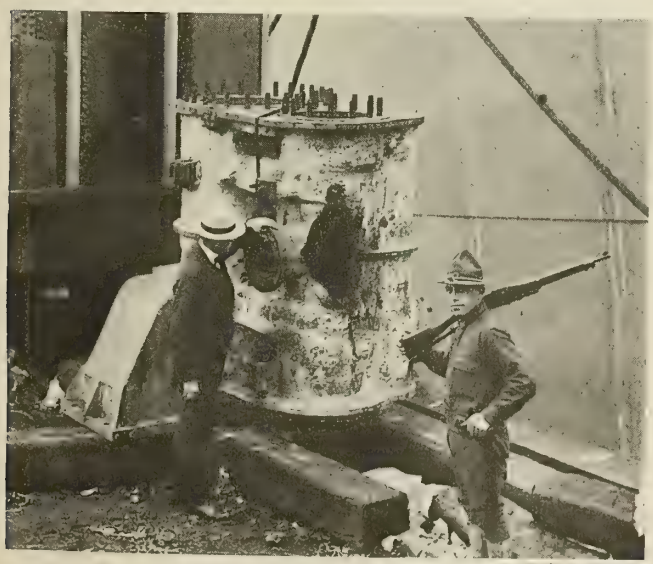
The City Council of San Diego, Cal., has granted permission to George W. Bush and Henry M. Coit, of San Diego, to build a shipyard on San Diego Bay.

The plant of the Tracy Brick & Art Stone Company, near San Diego, Cal., has been purchased by the Tracy Engineering & Shipbuilding Company, with the intention of converting it into a yard for the building of ships.

The Alaska Dry Dock & Manufacturing Company has leased a site of land at Juneau, Alaska, and has begun work on the construction of dry docks, marine ways, etc.

Several large companies are negotiating for water front property in the Borough of Queens, New York City, with the intention of establishing shipyards.

The McDougalz-Duluth Company, Duluth, Minn., announces that it will build a large shipyard at Ironton, Minn., on a tract of 85 acres.



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Engine Cylinder from German Ship *Ockenfels* Damaged by Crew Before Vessel Was Taken Over by U. S. Government

A charter has been issued in Dover, Del., incorporating the Great Eastern Shipyard & Dry Dock Company of New York. The announced capitalization is $30,000,000. It is impossible to find out who is back of this project.

F. R. Ward and S. Birkheimer, of Seattle, Wash., have organized the Ward & Birkheimer Shipbuilding Company, with headquarters at Olympia, Wash.

The Manitowoc Shipbuilding Company, Manitowoc, Wis., is making extensive improvements to its plant.

PERSONAL

H. W. Hand, formerly vice-president and general manager of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has been elected president of the company, filling the vacancy caused by the resignation of Henry S. Grove. Mr. Grove has been made chairman of the board of directors, H. B. Taylor has been elected vice-president, and J. K. Mull general manager and director.

H. B. Pickering, formerly connected with the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and the New York Navy Yard, Brooklyn, N. Y., is now connected with the Foundation Company, New York, as naval architect and marine superintendent of the company's varied ship interests.

D. H. Thomson has been elected president and treasurer of the Terry Steam Turbine Company, Hartford, Conn., filling the vacancy caused by the death of the late president, Mr. James Terry. N. L. Snow, formerly sales manager of the Terry Steam Turbine Company, has been elected vice-president.

John H. Bernhard, president of the Inland Navigation Company, New York, has returned to the United States after a six months' stay in Holland.

Charles E. Hyde, whose death in New York was recently announced, was the designer of the first triple-expansion marine engine ever placed in a ship in this country.

Frank A. Small, of Bath, Me., member of the firm of Percy & Small, builders of some of the largest schooners engaged in the Atlantic coastwise trade, died recently at Somerville, Mass., aged fifty-three. Mr. Small was formerly mayor of Bath.

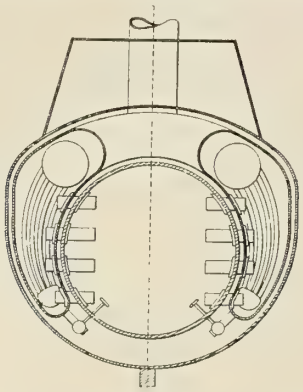
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,209,678. WATER-TUBE BOILER FOR SUBMARINES. GREGORY C. DAVISON, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.

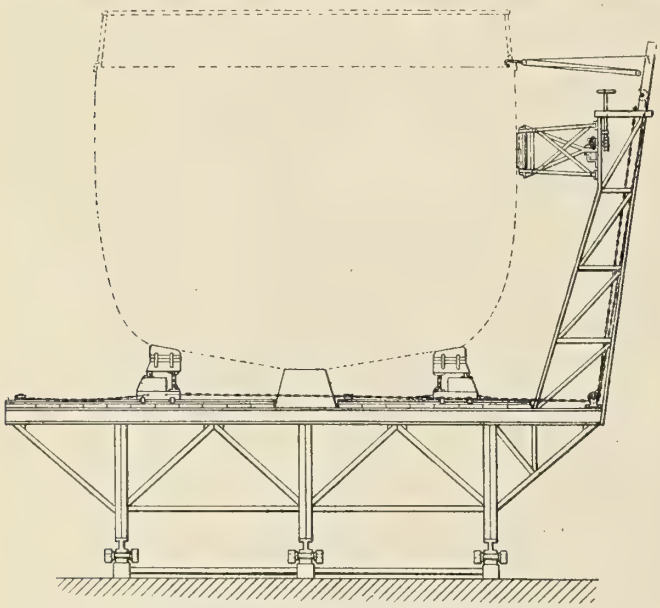
Claim 12.—In a submarine boat of the double-hull construction, in combination, a ballast tank located within the inter-hull space, a boiler compartment located within the ballast tank and spaced from the



bounding walls of the ballast tank, a water-tube boiler located in the boiler compartment, burners extending through the wall of the inner hull and the wall of the boiler compartment, and means for flooding said boiler compartment upon submergence of the vessel and operable from within the inner hull. Fourteen claims.

1,210,425. RAILWAY DRY DOCK. JAMES L. CRANDALL, OF MALDEN, MASS., ASSIGNOR TO CRANDALL ENGINEERING COMPANY, OF EAST BOSTON, MASS., A CORPORATION OF MAINE.

Claim 1.—In a railway dry dock, a cradle having an upright wing, and a thrust element arranged on said wing adapted for engagement



with the side of the vessel, comprising two toggle-members, and a thrust-roll and operating-means for said members.—Five claims.

1,206,850. VENTILATION SYSTEM FOR STORAGE-BATTERY CELLS. ALBERT S. HUBBARD, OF NEW YORK, N. Y., ASSIGNOR TO GOULD STORAGE BATTERY COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In a cooling and ventilating system for electric battery cells, a closed compartment for containing the battery, sealed battery cell casings in said compartment, an inlet pipe leading from a point outside of said compartment into said compartment, and comprising branches having sealed connections with said sealed casings, to provide communication with that portion of the interior of said sealed casings above the level of the electrolyte therein, an outlet pipe comprising branches having sealed connections with that portion of said sealed casings above the level of the electrolyte therein, to provide communication with the interior of the said sealed casings, and extending to a point outside of said compartment, and an exhaust pump attached to said outlet pipe.

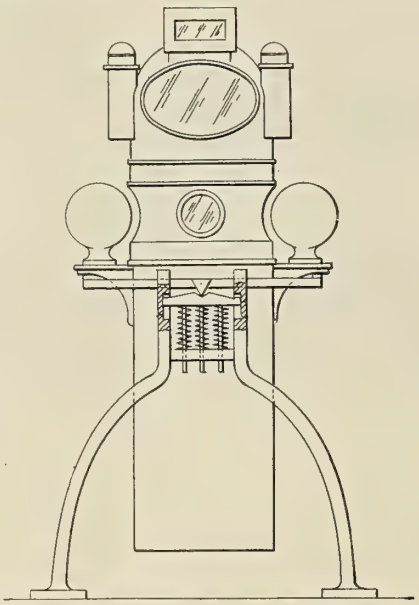
1,191,211. STEERING AND REVERSING TILLER. CHRISTOPHER J. MEYER, OF MILWAUKEE, WIS., ASSIGNOR TO EVINRUDE MOTOR COMPANY, OF MILWAUKEE, WIS., A CORPORATION OF WISCONSIN.

Claim 1.—A tiller provided with a releasing latch, and an operating handle, adapted, by rotation upon its own axis, to actuate the latch from one latching position to another on the opposite side of the axis about which the tiller swings. Eleven claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

102,644/16. RELATING TO SHIPS' BINNACLES. L. P. NELSON, S/S DOONHOLM, OF 2 SELBOURNE STREET, SOUTH SHIELDS.

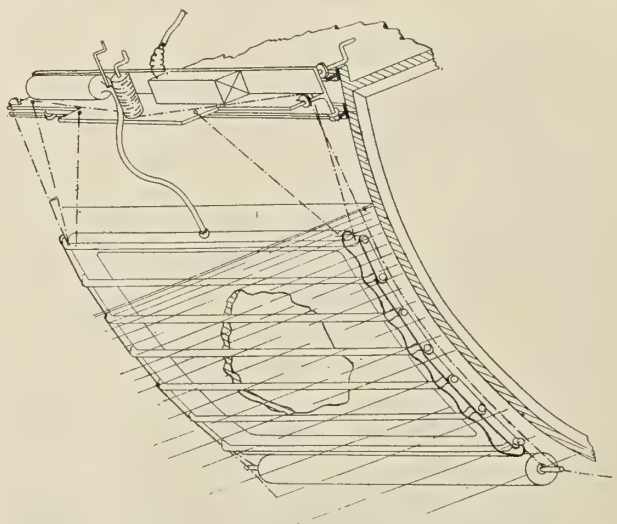
The binnacle rests by its knife edges or equivalents on the gimbal ring, which ring is provided with knife edges or equivalents, one on opposite sides of ring, which rests on a slide bar capable of vertical movement in slots in the upper part of the legs, which are bolted or otherwise secured to the deck. The slide bar is supported or rests on



springs bearing by their lower ends on a bar fixedly secured to the legs, said slide bar being provided with guide rods which pass through said springs and fixed bar. With an arrangement as above set forth and shown not only will the binnacle always remain plumb, but sudden shocks will be absorbed by the spring-cushioning device.

101,479/16. APPARATUS FOR CLOSING LEAKS IN SHIPS OR THE LIKE. DR. F. WULLYAMOZ AND G. MEYER, BOTH OF LAUSANNE, SWITZERLAND.

This invention relates to apparatus for closing leaks which comprise the combination of a mat made of flexible material, a roller carried by the mat, a frame adapted to make a tight joint with the hull of the ship, a truck traveling on longitudinal rails of the ship and



carrying the apparatus for manipulating the mat including ropes passing under the hull of the ship and so that the mat can unfold against a damaged portion of the hull and be kept there by the pressure of the surrounding water. In mats of this kind it has been proposed to provide electro-magnets or flexible india-rubber tubing on the frame adapted to make the joint watertight, but according to this invention a chamber inflated or filled with compressed fluid is used.

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A Costly Lesson

A BIG price has already been paid by the United States, and incidentally by her allies, for a needless mistake on the part of the Administration. Until the affairs of the newly-created Shipping Board had become muddled to the point of scandal the Administration apparently failed to realize that men appointed to office from various walks of life for political reasons, and invested with authority by the Government, might prove wholly incapable of carrying out a vast industrial project in which the majority of them had had no experience whatsoever.

Who in private life, if entrusted with a large sum of money for building ships, would turn the management of the business over to a farmer, a lawyer, a lumberman and a railroad man with any expectation of success? And yet, as originally organized, only two members of the Shipping Board were men who had had any experience in shipping affairs. One of these, who has frequently been called the "dean of the steamship fraternity" in the United States, resigned from the board within a few hours after his appointment, because it immediately became apparent that politics rather than practical business considerations were to govern the board. His place was filled by a farmer whose knowledge of the sea, ships and shipping was apparently limited to the information given in the seal of his native State, which depicts an ancient vessel on the stocks.

Now that a general house-cleaning has taken place in the Shipping Board, and all but two of its original members have been dropped, would it not be natural to suppose that this costly lesson, involving weeks and months of delay in carrying out one of the most important functions of the Government in the present crisis, would be heeded and the control of the country's marine affairs be entrusted only to men who have proved by years of service and achievement in the marine field that they are capable of controlling and directing the marine affairs of the country? It is very much to be doubted if the Shipping Board can successfully fulfill its purpose, or if the full confidence of the country will rest in the Shipping Board, until it is composed of men who are the most capable and experienced men that the country can produce from its maritime industries. If the Shipping Board must build ships, why should not one of the best shipbuilders in the country be a member of the board? If the Shipping Board is to regulate the steamship companies and fix or regulate ocean rates, why should not at least two of the country's foremost steamship men be included in the membership of the Board?

In the interests of the nation and our allies we protest against further political appointments to the Shipping Board. Give us a Shipping Board that knows ships and shipping, Mr. President!

The New Government Shipbuilder

UNQUESTIONABLY the Shipping Board Emergency Fleet Corporation fared better than the Shipping Board itself in the recent change in administration. Rear Admiral Capps, who succeeds General Goethals as general manager of the corporation, and who will have charge of the vast programme of shipbuilding begun by his predecessor, is first of all a shipbuilder and a recognized authority in naval construction, with a long record of usefulness which speaks volumes for his ability.

Rear Admiral Capps held the important post of Chief Constructor of the United States Navy for two terms at a time when naval construction was undergoing important developments. How rapidly the United States Navy forged ahead during this period, not only in size and strength but especially in the development of types of vessels, for many of which Rear Admiral Capps was responsible, is a matter of history.

While Rear Admiral Capps is primarily a naval constructor, nevertheless, his interest in and knowledge of merchant shipbuilding are evidenced by the splendid service which he rendered as chairman of the most important committee at the recent International Conference on Safety of Life at Sea, held in London just before the war. Rear Admiral Capps' wide acquaintance in the shipbuilding field, with his intimate knowledge of both theoretical and practical shipbuilding, will at once inspire confidence in his ability to carry out the task which has been entrusted to him.

Training Engineers for the Merchant Marine

UNDER the direction of Prof. Edward F. Miller, head of the department of mechanical engineering at the Massachusetts Institute of Technology, Cambridge, Mass., a course of instruction for marine engineers, to meet the demand for officers to man the Government emergency fleet, was begun on July 9. Similar courses have also been instituted at the Stevens Institute of Technology, Hoboken, N. J.; the Johns Hopkins University, Baltimore, Md.; the Case School of Applied Science, Cleveland, Ohio; the Armour Institute, Chicago, Ill.; Washington University, Seattle, Wash., and Tulane University, New Orleans, La.

At the Massachusetts Institute of Technology the men report at 9 o'clock in the morning, and work at the school until 4 in the afternoon. During the morning members of the instructing staff deliver lectures on the various branches of marine engineering, and the men are given an opportunity to write up the material which they obtain from the lecture. The entire afternoon is spent by the men in the laboratories of the school studying the con-

struction and operation of engines, pumps and other machinery; they also have an opportunity to write up the experiments which they have performed in the laboratory. At the end of the course of instruction at the school students are given training on ships at sea under pay.

The minimum qualifications for entering the engineering schools are: (1) At least two years' experience as oiler or water tender, or combined experience of two years in these positions on ocean or coastwise vessels. (2) A graduate from the engineering class of a nautical schoolship. (3) A graduate in mechanical engineering from a duly recognized school of technology with three months' sea experience. (4) A stationary engineer in full charge of a 1,000-horsepower plant. (5) A locomotive engineer who has had six months' experience in the engine department of ocean or coastwise steam vessels. (6) A journeyman machinist who has been engaged in the construction or repair of marine steam engines. (7) An apprentice to the machinists' trade who has been six months on a steam vessel. (8) Engineers of lake, bay, sound or river steamers. (9) At least three years as a fireman on an ocean or coastwise steam vessel.

The Submarine Problem

OVERCOMING the German submarine menace is, without question, the most important individual problem of the war. To aid in solving this problem, there has been organized, as one of the co-ordinate branches of the National Research Council, an engineering committee, with offices in Washington and New York, which is in contact with the work of the other committees of the Council and with the various problems which are brought to its notice by the several branches of the government. The primary purpose of this committee is to act as an intermediary between the needs of the government on the one hand and the vast field of potential human energy and genius represented by the engineers of the United States. Prof. W. F. Durand, head of the department of mechanical engineering at Leland-Stanford University, and formerly head of the department of naval architecture at Cornell University, is vice-chairman in charge of this work, and under his direction an appeal has been issued to the leading engineers throughout the country, not only to devote their best thought and study to this problem, but also to transmit to the committee any suggestions which may give promise of effective service in dealing with any or all of the various phases of the problem.

Aid in this work may come from a great variety of sources, as undoubtedly the solution of the problem is manifold and may represent a joint application of many different elements under the general heads of: (1) Detection of the presence or location of a submarine, (2) protection against torpedo attack by the submarine, or (3) offense against the submarine. It is obvious, therefore, that the field for the application of scientific engineering effort in the solution of this problem is extremely diversified, and helpful aid may be furnished from a line of engineering work apparently unrelated to naval matters.

In order that the problem may be intelligently dealt with, however, certain facts regarding submarine warfare should be understood, and for this purpose the following memoranda furnished by the Engineering Committee of the National Research Council will be found of value:

Submarines operate singly or in groups, as may seem best suited to local or special conditions. They are supposed, where circumstances favor, to lie on the bottom at rest, and, with listening devices attempt to detect the approach of vessels. On receipt of evidence that a vessel is approaching, they rise to a level permitting observation with the periscope, and then maneuver accordingly. When in water too deep to permit lying on the bottom, a submarine must maintain steerage-way in order to hold its level of submergence. The minimum speed at which this can be done ranges from 2 to 4 knots.

The maximum depth of submergence of a submarine is about 200 feet, while the usual depth of running is from 50 to 100 feet. German submarines have been supposed to return to the home base at intervals of from 30 to 35 days. The total radius of action will presumably range from 5,000 to 8,000 miles at a moderate cruising speed of 10 to 12 knots. The high speed emerged will range from 14 to 18 knots, or possibly more in later designs. The maximum submerged speed is about 10 knots. The time required from emergence to submergence ranges from one to three or four minutes. When submerged near the surface, the time required to raise the periscope to take a quick observation and lower it again may range from 15 to 30 seconds. If desired, the submarine can follow an undulating path, rising and submerging alternately, or it may run fully submerged but near the surface and take frequent observations through the periscope. Modern submarines are provided with two or three periscopes, so that the loss or destruction of one will not necessarily disable the boat.

Torpedoes fired from the submarines are presumably aimed by changing the direction of the boat. This, however, is not assured in all cases. The torpedo, in order to run true, must travel at an immersion of about 10 feet. In smooth water it may run at a shallower depth than in rough water.

At night submarines may operate with less liability of detection, but with greater difficulty in picking up their target. Sounds produced by the movement of a submarine through the water, including those traceable to the propeller, to movements of the rudder, etc., should permit of detection by the use of modern refined sound-detecting devices.

Although one of the most common means proposed by laymen and others for the protection of merchant ships against torpedo attack is some form of shield or net outside the vessel, nevertheless naval constructors generally are satisfied that the distance at which protecting plates or shields would have to be placed in order to secure immunity against torpedo attack is so great as to render their use of very doubtful practicability. The distance at which a protecting net, plate, shield or other means of exploding the torpedo before reaching the side of the ship must be located in order that such distance will render the effect of the torpedo harmless will depend primarily upon (1) weight of explosive charge, (2) depth of torpedo when exploded, (3) strength of the ship's structure. With modern practice, a depth of 10 or 12 feet, and, with the structure of modern merchant ships, distances of 20 to 30 feet, would perhaps be required in order to give good assurances against injury. With rough water and possibly much less submergence at the time of explosion, reduced distances of 15 to 20 feet might prove sufficient.

Although the above facts are generally well known, the Engineering Committee of the National Research Council is ready to furnish additional information on specific points, if practicable to do so, to engineers or inventors who are investigating any phase of this question. Notwithstanding the great number of individuals and other agencies that have for some time been engaged in the study of this problem, there is urgent need of the very best efforts which American engineers can contribute to its solution.

LETTERS TO THE EDITOR

American Shipping Should Be Subsidized

The July issue of Marine Engineering is of special interest in connection with the large number of new yards starting up and the question of the future of American shipbuilding. While I should like to feel sure that we will have a permanent shipbuilding industry in this country after the war ceases and matters settle back to normal, I cannot bring myself to believe that it will be a certainty unless the Government will at last pass a subsidy, which it most certainly should if it is going to maintain a high tariff.

When I read of the number of new yards being started almost daily, it seems as if the country had suddenly gone crazy on the subject of investing money in shipyard equipment, and I wonder if there is not going to be a serious reaction from it when peace is declared and the need for blockade runners has passed.

While Mr. Arthur F. Johnson may be right in his belief that we will be able to construct boats as cheaply as foreigners (which I doubt), how does he expect us to operate them under the American flag, and does he think that Europe will be liable to purchase many American-made boats at equal cost? I hope he is right, but apparently he entirely overlooks what I think is a most important question, namely, how can American capital own and operate boats in competition with foreigners without a subsidy when things return to normal conditions?

There is an enormous amount of capital now being invested in shipyards, and also, to my knowledge, in organizing for a large export trade, and it seems to me that it is to these capitalists we will have to look to wake up our Government and the farmers to a realization of the desirability, if not necessity, for such a subsidy as will assure a permanent merchant marine. The capitalists who are putting their money into shipyards and export companies might very well at the present time show some concerted opinion, indicating that they expect the Government and the people of the United States to pass a subsidy act which will insure the present investments they are making and which will provide our country with a merchant marine.

No longer can there be any doubt in the minds of anyone that an American merchant marine is a vital necessity as a protective measure in the event of war, even if our farmers do not believe in it as necessary for the welfare of our country in international trade and world politics.

Hartford, Conn. N. L. Snow,
Vice-President, Terry Steam Turbine Company.

Standard Ships and Standard Planning

A successful method by which results are predetermined in ships' construction will no doubt be quite usable at the present state of contemplated standard ship construction. Planning in advance, as all successful men of management know, is one of the necessary functions in the endeavor to reduce cost. Through the successful planning and routing of work, firms operating under the Taylor system and modifications of the Taylor system have attained business success—dividends. Through the acquisition of modern machinery, standard parts, bulk manufacture, interchangeable parts, and specialization, other firms have been successful—increased wages, better living conditions and lower priced products being the result of planning.

To apply the efficient methods of other industries is the problem which shipbuilding interests have been slow to acquire or attempt. That these methods are practical in all industrial activities and that results are assured any endeavors in this direction, can best be determined by the results obtained by F. W. Taylor, H. Emerson, H. L. Gantt, F. B. Gilbreth, their co-workers, and others.

With the present volume of standard ships to be built under the supervision of the Shipping Board standard planning offers results obtainable in no other way. If the ships are to be of one or a few types, the planning may be completed and used on all of each type of ship, slight changes being made as new and more economical methods are devised. A planning division handling these changes will immediately make any newly discovered methods known to all who are constructing this type vessels.

The planning offers further a check on all completed work, the percentage of completion and the status of

J O $\frac{P\text{-}1}{1a}$
DATE BEGIN WORK
COMPLETE

Specifications:—Construct bottom & side plating complete with butt straps, liners, etc, But not including plate fenders or angles connecting deck to shell plating.

OPER. NO.	OPER.	ALLOW.	UNITS	UNIT PRICE	NO. OF UNITS	TOTAL PRICE	DESCRIPTION OF WORK	BEGIN	COMP.
1	LO	0	Sq. Ft.	.01	2176	21.76	F Strake Plates		
16	PU	0	Holes	.001	9588	9.59	Parallel Liners in B Strake		
29	CK	0	Holes	.0018	11710	21.98	¾" Holes		
35	BO	0	Holes	1.00	48	48.00	Bilge Plates		
40	RM	0	Holes	.004	7312	29.25	¾" Side		
44			Plate	.75	8	6.00	Knuckled End Plates S-D-1 & S-D-10 (Day Work)		
46	Roll		Plate	1.00	16	16.00	Rolled Bilge Plates Square Body (Day Work)		
			Totals		107499	1141.30	$\frac{1141.30}{107499} = 0.0106$, Unit Price		

Fig. 1

J O	OPER. NO.	ALLOW.	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL PRICE	BOLTING-UP	BEGIN	COMP.
$\frac{A\text{-}1}{7c}$	35	0	Plate	1.00	48	48.00	Bilge Plates		
$\frac{A\text{-}2}{7f}$	25	0	Brack.	.50	44	2.20	Brackets		
$\frac{A\text{-}3}{7}$	10	0	Brace	.10	168	16.80	Angles in Trusses		
$\frac{A\text{-}1}{2f}$	5	4	Bolt	.05	16	.80	Bolt Chain Pipe PC. No. 10		
	7	4	Bolt	.05	32	1.60	Bolt & Pack Pad Eyes PC. No. 10		
			Totals		10684	509.75	$\frac{509.75}{10684} = 0.05613$, Unit Price		

Fig. 2

each individual job order. As the planning gives the amount of work for each job order, curves may be made showing the desired state of completion at stated periods; if the actual completion percentage runs above or below this curve, the steps to adjust are known.

For cost keeping and accounting the ship will be divided into groups, classified according to material and supervision, as shell plating, decks, framing, bulkheads, shipwright work, joiner and electrical work, piping, engines, boilers, auxiliary machines, painting, deck covering, equipment and hull fittings. The groups would be further divided into subgroups or job orders. For example, piping groups would be divided into plumbing, ventilation, voice tubing, pumping and drainage, sounding and air, main and auxiliary steam, etc.

The job orders would be divided into operations as illustrated on Fig. 1, which covers the work included in the construction of bottom and side plating on Navy standard coal barges. Each operation on each job order is worked out on the sheet, the number of units determined and prices set before starting work, this being a function of planning section. The old method consisted of making a drawing and sending it to the yard, the results being more or less dependent on the experiences of draftsmen, who usually have no practical experience, and in

most cases lack the knowledge of process work required to complete the developed plan. When operated with a planning section, the drawings are made and check print sent to planning section, the planning section being composed of the best mechanics available, who plan the work, noting necessary changes required on the drawing. These changes are based on: (1) the planners' knowledge of shop equipment; (2) the practical difficulties that present themselves in all work; (3) the most economical method of doing a piece of work; (4) the most suitable material for the purpose; (5) determining the most efficient and economical way, as two or more methods always exist for doing a piece of work. This procedure is a practical education to the draftsman, as in making the changes the practical difficulties which must be overcome are called to his attention.

After the work is planned according to job orders, as in Fig. 1, operation sheets are made, as Fig. 2. A sheet or sheets of this kind contains all the work for a single operation, as bolt-up, punch, countersink, plane, flange, furnace, cut-threads, bead, saw, paint, taper, etc. The operation sheets segregate the work under the various supervisors. A supervisor may be responsible for one or more operations, whereas a single job order may contain fifteen or more operations. The operation sheets further assist counters in locating work and checking off, the latter being done on cross section paper glued to right hand edge of sheet.

In making drawings an effort should be made to have work of not more than one job order on each plan, although it is permissible to have a job order covered by one or more plans.

The next consideration is "standard operation numbers." When the described method was installed, the two-letter mnemonic symbols were very satisfactory; with the installation of the Powell and Hollerith accounting machines, an extension of the numbers was simplified; it is now possible to get cost by date, group number, job number or operation number in a very short time, with a small amount of work. The standard operations are indicated by four numerals, two numerals to the right being numerical shop designation, two to the left indicating operation. Accounting and cost work is simplified by indicating all accounts and subdivisions by numerals. In Fig. 1, under operation, these numerical symbols would appear.

The description of column headings in Fig. 1 will be given, although partially explanatory; operation number is the numerical number under a specific job order and may appear in any sequence, its purpose is with description of work to readily identify an operation on operation sheets. Operation is the kind of work to be performed and is designated by numerals as described in the foregoing paragraph. As a specific example, L O (laying out) would be No. .0712, which is operation No. 7, shop 12, laying out and templating division. P U (punching) would be 1613, which is operation No. 16, shop 13, punch shed. Allow ——. This is taken from piecework schedule and is an extra price allowed in addition to straight piecework; No. 1 covers overhead work; No. 2 covers beveled shapes, rolled or furnace work; No. 3, closed in compartment or corner work; No. 4, odd or scattered work, the cost of preparation being allowed. Accessibility, continuity and difficulty of units are also considered in setting piecework prices. Unit, unit price, number of units and total price columns require no explanation.

The operation sheet has but one column which differs from the job order sheet—i. e., operation column is replaced by job order number. This cross files operations, showing from which sheet they were taken.

For a riveting sheet worked out by this method see, "Scientific Studies Applied to Riveting," MARINE ENGINEERING, September, 1916.

Balboa, C. Z. WILLIAM M. KENNEDY.

Development of Inland Waterway Transportation

Transportation on inland waterways, which is so strongly urged by the Government at the present time, owing to the inadequacy of the railway systems for handling the enormous amount of traffic created by the preparations for war, can be developed only through the co-operation of the railroads. The attitude of the railroads toward water transportation has been such, however, that only low class commodities are water-borne, such as coal, lumber, iron ore, flour, bran, feed, cotton, etc., and it is significant that the rates on these commodities are too low to make water transportation solely dependent upon them a success except under very favorable conditions.

Commodities such as the foregoing, which are the only ones generally conceded by the public as fit for inland water transportation (an impression which has been carefully developed by the railroads), are carried by the railroads between St. Louis and New Orleans, a distance of 1,245 miles by water, at rates varying from $2 to $3 per ton. In order to move these commodities by water someone must absorb the cost of carrying them to or from the river front either by truck, hand or rail. On through freight the railroads may be willing to assume the switching charges, but, if the freight originates or is delivered at points on the river, the railroads cannot assume the switching charges, and these charges must be assumed by either the shipper, consignee or water carrier. If it is the water carrier, he will have to add it to his rates or he will have to deduct it from his profits. If the shipper or consignee pays these charges, he will have to add them to his water rates. This charge for trucking or switching or carrying, varying, of course, as to distance, averages 60 cents per ton for delivery and 60 cents per ton for receiving.

Another charge which water transportation must always face, except in the case of a very few commodities such as grain, is that of loading and unloading. Without taking into consideration the cost of the boat, its equipment and administration during the time of being loaded and unloaded, this loading and unloading of these commodities will average not less than 40 cents per ton for handling over the present inadequate river terminals.

There are thus fixed charges not effected by the carrier which amount to more than $2 per ton, which water carriers will have constantly to meet on all such commodities as those mentioned above, which, according to the railroads, or misguided supporters of water transportation, are the only commodities fit for water transportation. No water transportation company can ever be a success as long as it has to assume these charges, or, if these charges are not materially lessened.

There are three solutions to this condition. One is the expenditure of millions of dollars for the construction of perfect river terminals, making such terminals the only place of accumulation of freight, regardless of whether the transportation is to be by rail or water, so that the haul to and from the river front is eliminated, and the cost of loading and unloading at the terminals is brought to an absolute minimum.

The second solution is by the railroads increasing their rates on such commodities as are moved to-day at a loss

to themselves; for instance, flour is moved between St. Louis and New Orleans for $2.80 rail rate over a rail distance of 700 miles or 3 mills per ton mile, equal to the average lowest charge on coal on the Lehigh railroad, which is the most economical railway coal carrier in America.

The third solution is to build boats which are equipped to carry better class commodities and give these the proper protection and speed of delivery necessary to carry these commodities.

It would take several months for the readjustment of all transportation rates, but it is possible for the railroads to give quicker relief by reducing their interior rates. For instance, from New Orleans to Memphis, a rail distance of 400 miles against a water distance of 800 miles, freight is carried by the railroads at far below the average charges, but from Memphis to an interior point at a distance of, say, 80 miles, a charge is made which is twice the cost for which they have carried the freight along the river over 400 miles; in other words, a tenfold higher rate. Let the railroads adjust such rates, and if they wish to hide, perhaps with honest intent, behind the defenses they have always made, that rates on shorter hauls cannot be proportionately less as compared with long hauls, because their terminal expenses remain practically the same and the density of the population might give them less freight per mile of rail, let them at least agree to charge nothing else but the actual cost of carrying between these short-haul points plus the fair average profits made on their freight in general.

There is still another way in which the railroads may assist water transportation. The Inland Navigation Company, which was formed for transportation service on the Mississippi River between St. Louis and New Orleans, and of which the writer is president, was organized with the idea that the solution of water transportation is in the carrying of first-class commodities. It was soon found, however, that for various reasons it was impossible to secure sufficient of this first-class freight in St. Louis alone. It was found necessary to go outside of this territory—for instance, to Chicago, Indianapolis, etc. The first class rate from Chicago to New Orleans is $22 per ton, if moved all rail. If it is carried via St. Louis over two connecting railroads—for instance, the Wabash and the Iron Mountain—then the Wabash gets for its portion of the haul $7.12 and the Iron Mountain for the haul between St. Louis and New Orleans gets $14.88. Now if the Wabash gives the freight to the inland Navigation Company in St. Louis, they keep out of this $22 the sum of $9.10 and allow the Inland Navigation Company $12.90. Thus the railroads take 28 percent more money at the expense of the water transportation service for actually less service.

From this $12.90 which remains, the water transportation company must make a reduction in order to get the shipper to agree to their routing, which involves a rehandling of the freight and a delay. The expected reduction is 20 percent of the total rail rate, or $4.40, with the result that out of the $22 the water transportation company gets only $8.50, where a competitive rail carrier between similar points gets $14.88.

In addition, the water transportation company has the obligation to load and unload, which the railroad does not have. Thus, out of the remaining $8.50, the water transportation company must set aside at least $2.50 for loading and unloading and drayage or switching charges, which finally leaves for carrying first class freight between St. Louis and New Orleans, out of the total of $22, only $6, as against the competing railroads' $14.88.

As the attitude of the railroads in regard to this matter is a direct violation of both the spirit and letter of the law, the case was brought before the Interstate Commerce Commission. After a year of delay the Interstate Commerce Commission finally reached a decision and ordered the railroads to make joint rates with the waterway transportation company. They specified, however, that the railroads maintain joint rates, which shall be no higher than those maintained by them with rail carriers between the same points. The railroads declared, however, that, although having been ordered by the Interstate Commerce Commission to make rates not higher than the all-rail rates, nevertheless they were not instructed to make lower rates. Therefore they refused to do so.

Therefore the last solution of the problem of water transportation is by the railroads abandoning this attitude entirely and making joint rates with the water transportation companies, which they can do without the least loss or cost to them. If they do this, they will not only assist existing water transportation, but they will have made it possible for many new water transportation companies to come into existence, make profits and serve their country.

John H. Bernhard,
President, Inland Transportation Company.
New York.

Further Remarks on Reduction Gears of Floating Frame Type

BY JOHN H. MACALPINE

My paper on "Marine Applications of Reduction Gears of Floating Frame Type," read before the Institution of Naval Architects this spring, and reprinted in large part in Marine Engineering for June, gave rise to considerable discussion and the request for additional information. The reply in the Transactions of the Institution will, of course, not appear for a considerable time, nor will it reach all the readers of Marine Engineering, hence I desire to offer the following additional remarks here:

The earlier floating frame gears, with the exception of U. S. collier *Neptune's* present gears, had comparatively low power constants. This constant was gradually raised as experience was gained, and I shall now give data of some of the more recent gears with higher constants, and of the *Neptune's* present gears.

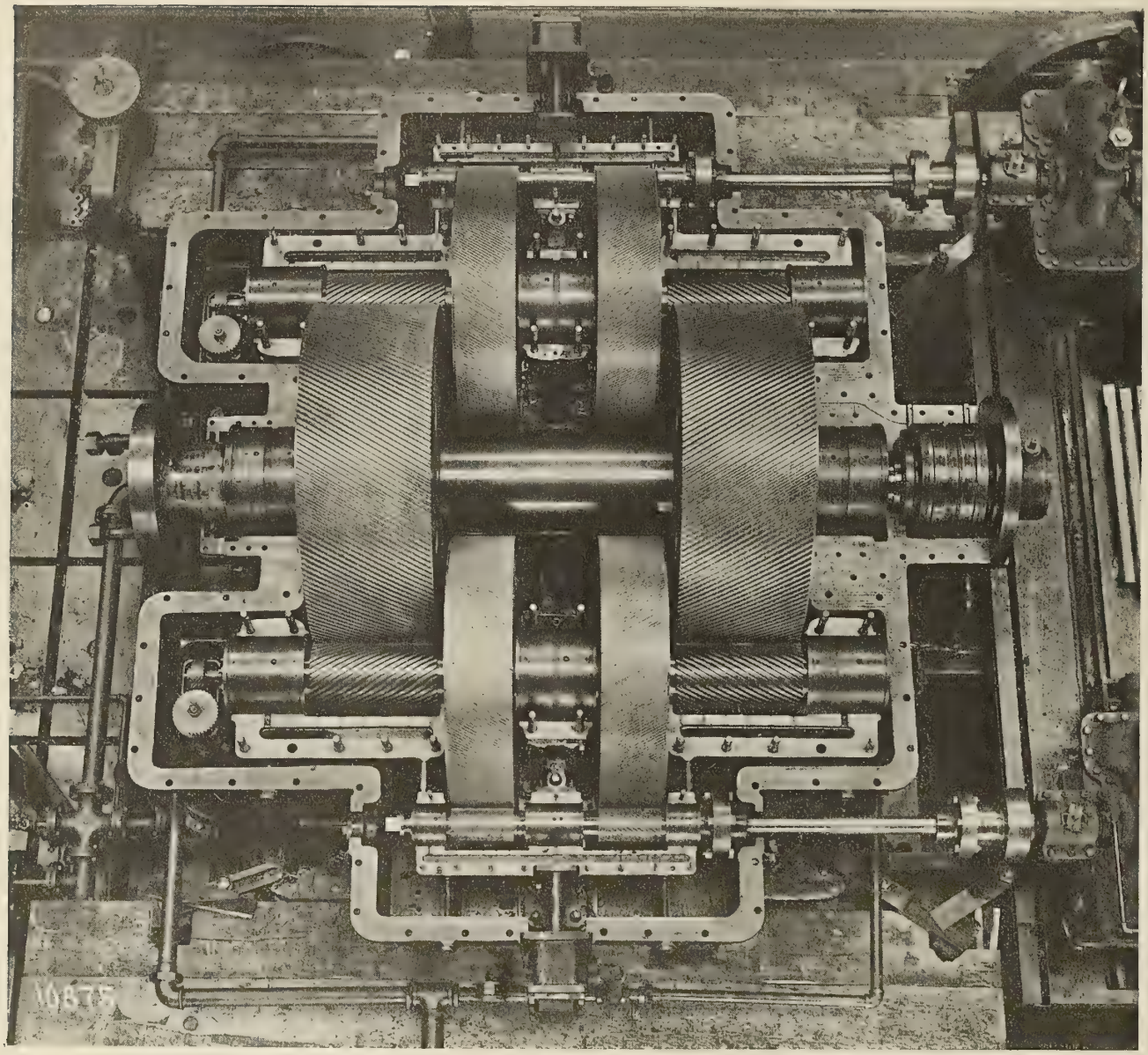
The gears supplied to the following three firms were from the same patterns: (A) Eastman Kodak Company; (B) Federal Rubber Company; (C) Aluminum Company of America. Pinion 5 inches pitch circle diameter, 3,600 revolutions per minute; overload rating 1,250 kilowatts; normal rating, 1,000 kilowatts. Each drives a D. C. generator, for which, in what follows, I take the efficiency as 92 percent. The dates on which these units were put in service are as follows:

(A) April 4, 1914; works at seven-eighths of overload rating about 16 hours per day, 7 days per week. This gives a power constant of 3.54.

(B) April 12, 1915; works at 1,000 kilowatts usually with frequent overloads up to 1,250 kilowatts, for 24 hours per day and 7 days per week. This gives a power constant fluctuating between 3.24 and 4.05.

(C) November 1, 1914; works 12 to 16 hours per day, 6 days per week, at a fluctuating load up to 1,250 kilowatts. This gives a maximum power constant of 4.05.

Gears were supplied to (D) the Jacob Ruppert Brewing Company and (E) the Schoenhofen Brewing Company. Pinion 3.9 inches pitch circle diameter, 3,600 revolutions per minute; overload rating, 550 kilowatts. These run 24 hours per day in summer, for 6 days per week,



Double Reduction, Floating Frame Type Westinghouse Turbine Reduction Gear of 3,400 Horsepower. Speed Reduction, 3,740 to 72 Revolutions per Minute

at from 400 to 500 kilowatts. The power constant for 500 kilowatts is 3.41. (D) was put in service on June 5, 1914, and (E) on August 14, 1914.

All these have given excellent service and are in perfect condition to-day. Indeed, the same can be said of every floating frame gear which has been put in service, except the first gears of U. S. S. *Neptune*. These were replaced for no defect of the gears, but in replacing the turbines the revolutions per minute were much raised, requiring change of gear ratio.

U. S. S. *Neptune* has been in service since her official trials in November, 1915, at speeds from 12 knots to over 14. I am informed that there have been considerable periods at speeds which would give a power constant from 4.3 to 5.3. Her most continuous service has been in the last year and the log shows that between April 1, 1916, and March 31, 1917, she steamed about 40,000 miles. The speed for most of this distance was from 12 to 13 knots, which would give power constants from about 3.5 to 4.3. The gear teeth, examined a few days ago, are in excellent condition.

The present practice of the Westinghouse Machine Company is to make a power constant of 3.0 at normal load for gears driving electric generators, the value being kept a little low, as a short circuit greatly increases the stress for a short period; a value of 3.5 for merchant ships, as these may run frequently and for long periods at full speed, and a value of 4.0 for naval vessels.

It has been stated that rigid gears have been frequently designed for power constants about as high as those I gave in the foregoing paper. If so, either the data have not been published or I have overlooked it. In the "Table of Gear Data" (*Engineering*, Vol. CI, page 492) in my article "On Reduction Gears," I gave the three highest examples of power constants for marine rigid gears which I knew. These were:

(*a*) The *Vespasian*, power constant = 3. This is the highest result of a progressive trial trip and was of a few minutes' duration. The published data show that, for the average speed of the ship, the power constant is 1.85.

(*b*) Highest trial run of S. S. *Tuscania* gave 1.80; also of a few minutes' duration.

(*c*) Official measured mile trial results of S. S *Ciudad de Buenos Aires* and *Ciudad de Monte Video*, gave 2.58

for the high pressure pinion and 1.29 for the low pressure. Values for land gears are usually lower than for marine gears.

Recent proposals seem to indicate that power constant for rigid gears shows no tendency to rise. They appear to fluctuate a great deal, suggesting trouble from the higher values.

Some think that I have overestimated the effect of minute errors of alinement of rigid gears, and that the teeth of such gears do bear evenly over their whole length. It was the conviction, arising from purely theoretical considerations, that minute errors of alinement would have serious effects, which gave rise to the invention of the floating frame. (See *Engineering,* Vol. LXXXVIII, page 378, Fig. 8, and text referring to it.) But this is no longer only a theoretical conclusion. The Westinghouse Machine Company have built both floating frame and rigid gears and know the great care which must be exercised to attain as perfect alinement as possible in the latter. The gear case, after being rough machined, is left till the internal stresses have relieved themselves as much as possible; still better results can be attained by annealing. The finishing cut is then made. No such precautions are necessary in building floating frame gears. Again, they found that the greatest care was necessary in bolting down the gear case; as predicted, the screwing down of a holding-down bolt could readily warp the casting and put the pinion and gear axes out of line. In small gears the difficulty can be largely met by bolting down the gear case at three points and keeping all the rest of the surface free. But this is not practical in large marine gears. Again, the high power constant which can safely be adopted in floating frame gears, as compared with those by the most experienced designers of fixed bearing gears, is convincing proof of the accuracy of this conclusion. As stated by Mr. J. A. Davies, engineer Marine Department, the Westinghouse Machine Company: "After an extended experience with gears of the fixed bearing type and those having pinion frames flexibly supported, we are unalterably of the opinion that the latter type of gearing, as described by Mr. Macalpine in his London *Engineering* articles (see *Engineering,* London, Vol. CI, page 415) is greatly to be preferred, even down to the smallest sizes."

It has been stated that examination of the teeth of some rigid gears has shown that they "bear evenly over their whole lengths." But, conclusive proof that gear teeth are bearing evenly over their whole length cannot be obtained by examination. If they have been bearing so hard at one part that they cut, the cutting will usually spread all along and little can be learned unless the gear is stopped very soon after this action starts. Examination will show if a portion of any tooth has not been bearing at all; but if there is bearing varying from a light pressure at one end of the tooth face to a heavy pressure but less than what will cause cutting at the other end of the face, the teeth will soon be brightened all over. It cannot even be concluded that the teeth are bearing all along at the same time, as working of the ship's bottom or any straining action may cause the bearing portion to change. As I stated in a letter recently (*Engineering,* Vol. CII, page 527): "When a grinder polishes a surface he only makes contact between the emery wheel and a small portion of the surface at one time." Improvement of pressure distribution cannot be made by giving the bearings ample clearance, as has been proposed. If a proper clearance is given, the oil film under pressure forms over a large arc of the journal. If this clearance is enlarged the effective arc is quickly restricted and the journal and brass come more nearly into contact. Further, no compensation of any value can be obtained through the oil film, for, as I showed in the recent letter just referred to, the thickness of the oil film is only very slightly responsive to change of total pressure from the journal. Besides, the change of bearing pressure which is supposed to alter the film thickness is due to bad distribution of tooth pressure. I need not rediscuss the question here. (In a footnote to that letter .0007 is printed instead of .00007; but as it is the difference of two numbers which are also given, this should cause no difficulty.)

The only way to insure uniform tooth loading is to reduce redundancy as much as possible; or, as Sir William E. Smith stated it in the discussion, in terms of the condition laid down by my old teacher, Sir William Thomson (Lord Kelvin), "unnecessary geometrical restraints should be avoided in all mechanical constructions." This the floating frame does. I must strongly contradict the statement which has been made that it is a complication; on the contrary, all the engineers of the Westinghouse Machine Company look on it as a great simplification of the construction and as making the proper action of the teeth a certainty.

Some criticisms seem to proceed on the assumption that the torsional error of the pinion is the most serious one. I have examined the various errors at great length in my article "On Reduction Gears," and have shown, and experience confirms, that the alinement error is far the most serious in rigid gears and that it does not exist in floating frame gears. Far after that comes the cross-bending error and torsional error, usually in the order named if the pinion has two bearings. If the pinion has three bearings, the order of importance of these two errors is reversed. The numerical investigation I have given shows that the tonsional error is so small that even were it obliterated the safe power constant would be only slightly raised. The anticipation recently made that a considerable reduction of the torsional error would allow the same power constant as for floating frame gears appears to me quite fanciful.

Unusual Photograph of Reduction Gear With Covers Removed

I show in the figure a very compact and light design of double reduction gear of which the Westinghouse Machine Company are now building a good many. A three-bearing floating frame supports each of the four pinions, and all the gearing is contained in one casing. The upper halves of all floating frames are removed, and it will be seen that the gears of each first reduction, which are solid with the pinions of the second reduction, are also carried in the floating frame. It is of 3,400 horsepower at 3,740 revolutions per minute of the first pinion. The weight, deducting the Kingsbury thrust block, the casing for which is cast on the gear case, is 34 tons. The overall dimensions in plan are 9 feet 8 inches fore and aft by 12 feet athwartship, giving 116 square feet. The foot bolting to the ship's keelson is 8 feet 6 inches by 10 feet 6 inches, giving 89.25 square feet. The reduction is from a turbine speed of 3,740 revolutions per minute to a propeller speed of 72 revolutions per minute.

In my paper before the Institution of Naval Architects (see Marine Engineering, June, page 260) the total horsepower of floating frame gears built and building is given as 738,169. This figure to-day stands at 1,183,764, which is a very satisfactory increase for the time, but contracts for the machinery for the merchant vessels which are to be built by the United States Shipping Board Emergency Fleet Corporation have not yet been let, and as soon as these contracts have finally been placed this figure will be vastly increased.

Composite Cargo Steamer of 5,500 Tons for U. S. Shipping Board's Emergency Fleet

Designed by William B. Ferguson, President and General Manager Bayles Shipyard, Inc., Port Jefferson, Long Island, N. Y.

AS a logical sequence to the description given in our July issue of the 3,500-ton wooden cargo steamer designed by Theodore E. Ferris, naval architect, for the United States Shipping Board Emergency Fleet Corporation, we print herewith plans and extracts from the specifications of a larger vessel of composite construction, designed by William B. Ferguson, president and general manager of the Bayles Shipyard, Inc., Port Jefferson, Long Island, New York, for the Shipping Board fleet.

Bids for the construction of several vessels of this type have been submitted to the Shipping Board by this company, and in order to provide for this work, as well as for the carrying out of large private contracts, the Bayles shipyard has been increased by the acquisition of the Radel shipyards, also located at Port Jefferson. This gives the Bayles yard a total frontage of approximately 1,600 feet on the harbor and adds to its equipment three marine railways, a machine shop, joiner shop and the public dock of Port Jefferson.

William B. Ferguson, president and general manager of the Bayles Shipyard, Inc., from whose ideas the composite vessel has been designed, was formerly a naval constructor in the United States Navy and is a brother of Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. The other officers of the Bayles Company are as follows: Vice-president, H. P. Bope (also vice-president of the Carnegie Steel Corporation); treasurer, H. M. Williams; chief engineer, Bruce E. Loomis, and naval architect, S. C. Weston.

The principal dimensions of the ship are as follows:

Length overall	357 feet 6 inches
Length between perpendiculars	340 feet
Beam, molded	47 feet
Beam, outside of fenders	49 feet 6 inches
Depth, molded	28 feet
Mean draft	23 feet 3 inches
Displacement on mean draft	8,230 tons
Gross registered tonnage	3,880 tons
Net registered tonnage	2,100 tons
Deadweight on mean draft	5,500 tons
Sea speed, loaded	10 knots
Indicated horsepower	1,500

The composite steamer was designed to provide a ship which could be economically constructed in spite of the scarcity of material. Because of this scarcity of material the vessel is a compromise between an all-wooden vessel and one built of steel—a compromise, in that the rapidity of construction and possible ease of obtaining the material, which are the points in favor of the all-wooden boat, would be combined with the greater possible size and increased strength afforded by the all-steel ship.

It is a well-known fact that the larger the ship the less the cost to construct and operate per ton of carrying capacity. The fact that there is a limit beyond which the size of the all-wooden ship cannot be carried practically is the principal handicap which this type has to meet. Therefore, for economy it is necessary to turn to a substitute approaching the all-steel ship. But the market conditions are not favorable at this time for obtaining steel plate in quantity, and therefore substitutions must be made for some of this material.

Employing Structural Shapes a New Departure

Owing to the unprecedented activity in shipbuilding the demand on the steel mills for the structural shapes peculiar to ship construction and for steel plate, which was formerly but a small proportion of the output of the mills, is greatly in excess of the amount which the mills could deliver within a practicable time. The structural steel shapes used in building construction, however, are more easy to obtain in the open market, as the mills produce far greater quantities of these shapes and a sufficient supply can be delivered from the supply on hand.

By exhaustive calculations and research it was found that these structural shapes could be used in ship construction, notwithstanding the fact that their strength per unit of section is somewhat less than ship steel and that difficulty would be encountered in working them to the elaborately curved surfaces of the average ship's hull. By using wood planking in place of the steel shell plating, a much lesser quantity of steel plate will be required, although the steel framing is designed to meet all requirements of strength.

Characteristics

To simplify the construction of the vessel to the greatest possible degree without impairing its utility, its efficiency of performance or its appearance is an important consideration, for not only would this effect a saving in money, but it would also affect the length of time necessary for building a fleet of such boats, which is perhaps the most important feature.

With this end in view, the ship was made rectangular in midship section, with this uniform body extending for 58 percent of its length, or 187 feet. The bottom has no dead rise, being flat from side to side, except for the turn of the bilge, which was made on a radius for simplicity. The sides are straight with no tumble home and the decks have no camber.

Advantages

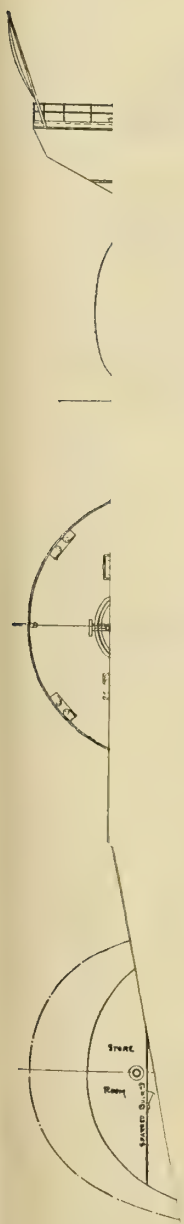
The features enumerated above make it possible to standardize the vessels and construct them in much the same manner as standard buildings are erected. The structural parts can be fabricated at the mill and shipped in that condition, it being only necessary to assemble them when they reach the shipyard. With the substitution of the I-beam floor for the usual "built-up" section, an enormous amount of riveting is eliminated. More than half the remaining amount of riveting can be done by power at the mill.

The design is arranged so that if at any time it is found that steel plates can be readily procured the wood planking can be removed and steel plates substituted, thus converting the vessel into a standard steel ship.

Life

The life of a composite ship with yellow pine planking is placed at from twelve to fifteen years. It is thought, however, by the designers that it would be desirable to remove

Supplem



Composite Cargo Steamship of 5,500 Tons Deadweight Capacity

Designed by William B. Ferguson, President, Bayles Shipyard, Inc., Port Jefferson, N. Y.

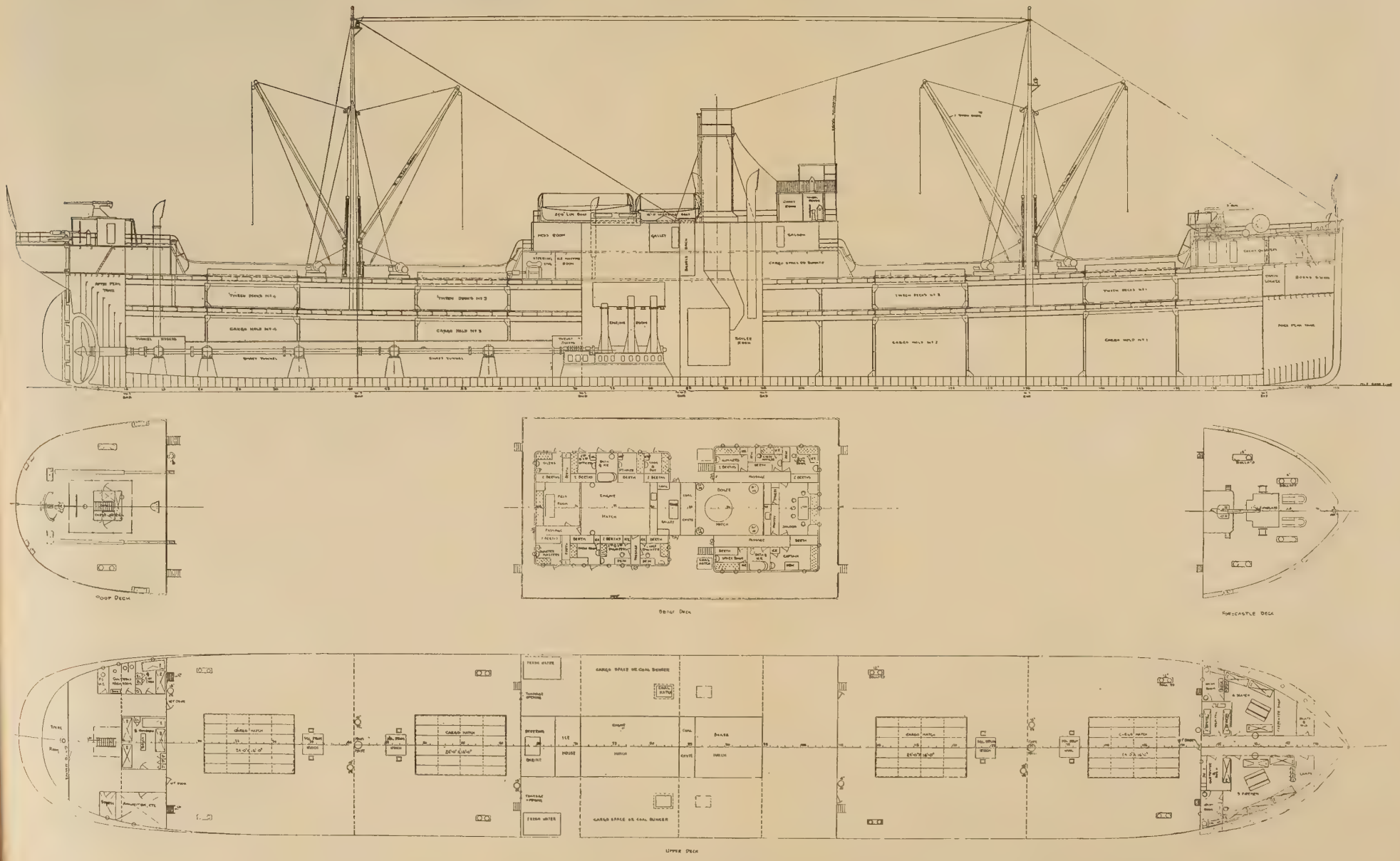


Fig. 1.—Profile and Deck Plans

Composite Cargo Steamship of 5,500 Tons Deadweight Capacity

Designed by William B. Ferguson, President, Bayles Shipyard, Inc., Port Jefferson, N. Y.

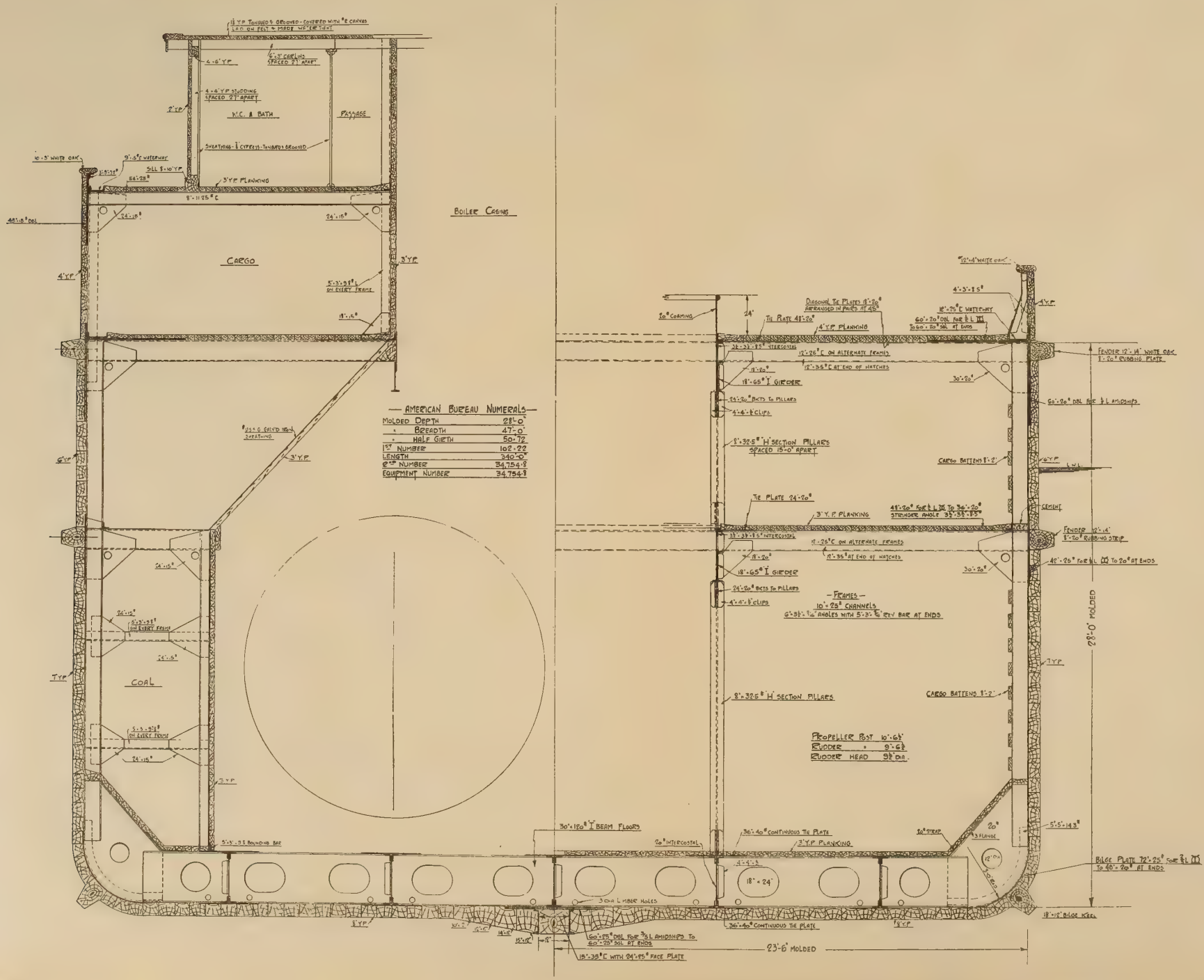


Fig. 2.—Section Through Boiler and Cargo Space, Showing Scantlings

the wood planking in about eight years, at which time corrosion between the steel and wood will probably begin to be noticeable. After the steel plating is substituted for the wood, the vessel will be good for as long as any other steel boat.

Cost

A comparison of costs between the three types of ships shows the advantage to be with the composite vessel, when the time necessary to construct and the life of the vessel are taken into consideration. The cost of the wooden ship will be about $125 (£25.6) per ton deadweight capacity, which would for this sized ship (if it were possible to build a wooden ship as large as this) total $687,500 (£141,000). An ordinary steel ship of this size would cost, even with the government prices on steel, in the neighborhood of $150 (£30.8) per ton, which will total $825,000 (£169,000). The composite vessel will cost, if built in quantities sufficiently large to make the mill fabricating idea practicable, about $136 (£28) per ton, which will total about $750,000 (£153,500).

From this it will be seen that the composite vessel will cost only a small amount more than the wooden vessel, while it has a life probably twice as long, and will cost considerably less than the steel vessel and is just as serviceable.

Type Generally Approved

The plans and specifications have been approved by Lloyd's Registry of Shipping, which gave the vessel a rating of "A-1" for twelve years; approved by the American Bureau of Shipping, which classed the ship "A-1" for fifteen years; approved by Theodore E. Ferris, for the United States Shipping Board. On the strength of this last approval, bids were submitted to Mr. Eads Johnson, New York representative of the U. S. Shipping Board.

General Arrangement

The vessel is of the two-deck type with forecastle, short poop and bridge house amidship. Three-inch guns are mounted fore and aft. The aft gun, being mounted on top of a small deck house which forms a companionway to the gunner's quarters, permits of better defense against submarine attacks, due to the greater possible depression of the gun which allows of action at closer range.

The forecastle provides space for hospital, wash-room, quarters for seamen, firemen and boatswain. The midship deck-house contains quarters for officers, petty officers, wireless operators, chief gunners, engineers, oilers, cooks, messmen, etc. The poop contains quarters for the gun crew, stores and ammunition.

The vessel has a semi-elliptical stern and straight stem. Two wood pole masts, each fitted with three 3-ton booms, serve the holds. Access is gained to the holds through four cargo hatches.

'Tween decks the vessel is divided by six watertight transverse steel bulkheads into four cargo holds, fore and aft peak tanks and machinery space. A non-watertight steel screen bulkhead is fitted between the engine and boiler rooms. Water ballast is carried in the fore and aft peak tanks. Two 50-ton capacity feed water tanks are fitted in the engine room immediately abaft the screen bulkhead. Culinary water is carried in two steel tanks, having a total capacity of 8,000 gallons, located in the bridge space.

Framing

Twenty-pound plate forms the stem and extends down below the turn of the forefoot, so shaped as to efficiently connect with the flat keel plate. Tie plates connect the stem with the two forward frames. The stem proper is of white oak, rabbitted to received the planking.

The stern frame is of forged or cast steel designed to provide ample landing surface for the planking.

A box type keel is fitted, the keel being built up of channels and plates with wood filling. The vertical keel consists of 20-pound intercostal plates clipped to the transverse floors with angles. At the ends the weight is reduced to seventeen pounds. A 36-inch by 40-pound tie plate laid fore and aft over the tops of the floors connects the vertical keel plates by double clips. This tie plate is reduced to 17 pounds at the ends; butts are single strap and treble riveted. Four 20-pound side keelsons are fitted intercostal.

Frames of channel section extend from the upper deck to the upper turn of the bilge. Angle frames are fitted to the bilge brackets and lapped on the side frames and to the floors at the ends. This type of framing extends between the fore and aft peak bulkheads. Framing fore and aft of these bulkheads is of angle section with reverse bars.

The floors consist of 30-inch by 120-pound structural I-beams, continuous from side to side. As the vessel fines away fore and aft 16-pound plates with 1½-inch by 3-inch by 11.9-pound double angles are used instead of the I-section. Lightening holes are cut so as to assure the greatest possible carrying capacity. Bilge brackets are of 20-pound plate, with a flange on the upper edge.

Lower and upper deck beams are of channel section, 12 inches by 25 pounds on alternate frames. Lower deck stringers are 48 inches by 20 pounds, plates running for one-half length reduced to 36 inches by 20 pounds at ends. Three-and-a-half inch by 8.5-pound stringer angles are fitted inside of the frames.

Fore and afters of 18-inch by 60-pound I-beam sections are fitted at the ends of the hatches and are supported by stanchions. Tie plates 24 inches by 20 pounds run fore and aft each side of hatches. These tie plates are connected to the stringer plates by diagonal ties 18 inches by 20 pounds running at an angle of 45 degrees in pairs.

The upper deck stringer plates are 60 inches by 20 pounds, double for half the length and reduced to 42 inches by 20 pounds single plate at ends. A 15-inch by 30-pound channel forms the stringer and watering angle. Forty-eight-inch by 20-pound tie plates run fore and aft each side of the hatches. A continuous 18-inch by 65-pound I-beam section runs fore and aft each side of the hatches and is supported by stanchions. The diagonal tie plates are 18 inches by 20 pounds.

To assist in strengthening the vessel against hogging and sagging diagonal tie plates 18 inches by ¾-inch run from the bilge strake to the upper sheer strake in pairs at an angle of about 45 degrees. The planking is notched in way of these tie plates.

At the turn of the bilge a 72-inch by 25-pound fore and aft strake is run lapping on to the floors and side frames. The sheer strake at the second deck is 42-inch by 25-pound for one-half the length and reduces to 20 pounds at the ends, 60-inch by 20-pound doubled for one-half the length, and reduced to 48-inch by 20-pound being used as an upper deck sheer strake at the ends. Bridge sheer strake, 45-inch by 15-pound doubled; poop, 36-inch by 14.7-pound; forecastle, 36-inch by 15½-pound.

The six watertight bulkheads are of 15-pound plating in the lower strake, reduced to 10 pounds between decks. A strong vertical web stiffener extends from the second keelson to the deck stringer on each side of the vessel built up of 20-pound plate 30 inches deep at the bottom, 18 inches at top with 5- by 5-inch by 16.2-pound face bars. Intermediate vertical stiffeners of 8-inch by 11.25-pound channel sections are placed on 24-inch centers on

opposite sides of the bulkhead. Stiffeners in way of keelsons are bracketed to same. Fifteen-inch by 33-pound channels are run as horizontal stiffeners between the vertical webs and between the web and sides of the ship. Brackets tie these stiffeners to the frames.

The screen bulkhead which separates the engine room from the boiler room is made up of 10-pound plate. Coal bunkers are provided outboard of the engine and boilers. They are built of 3-inch yellow pine planking sheathed with No. 16 U. S. S. G. steel forming fore and aft bulkheads. This planking is supported by 16-inch by 15-pound channels on 24-inch centers. Coal is also carried in the bridge space when necessary and auxiliary coal capacity can be arranged for in the cargo hold.

Hold stanchions are 8-inch by 32½-pound "H" sections. 'Tween deck stanchions which land immediately over hold stanchions are of the same section and weight.

Decking and Planking

The second deck, forecastle, poop and bridge decks are planked with 3-inch yellow pine, 4-inch yellow pine decking being used on the upper deck. Planking throughout is yellow pine worked in lengths not shorter than 20 feet. Bottom and bilge planking is 8 inches thick, thickening out to 15 inches at the garboard strake. Seven-inch planking is used between the upper turn of the bilge and the second deck. Between the second and upper deck the planking reduces to 6 inches and to 4 inches in way of bridge, poop and forecastle. Bilge keels terminate at frames 12 and 55.

Fastenings

All fastenings, other than rivets, are composition brass or galvanized iron, bolt fastenings through wood being driven with a drift from 1/16 to ⅛ inch, according to nature of wood and length of bolt. Bolts exposed to weather are plugged. Grommets are fitted to all such connections as are necessary. Tree nails are of locust.

Rudder

The rudder is of the single plate type with arms keyed to the main piece, the stock and main piece being of wrought steel.

Propelling Machinery

The vessel is propelled by a vertical inverted triple expansion engine, developing 1,500 indicated horsepower, with cylinders 21½ inches by 36 inches by 63 inches diameter by 42 inches stroke. The engine turns a single four-blade, right hand sectional adjustable propeller.

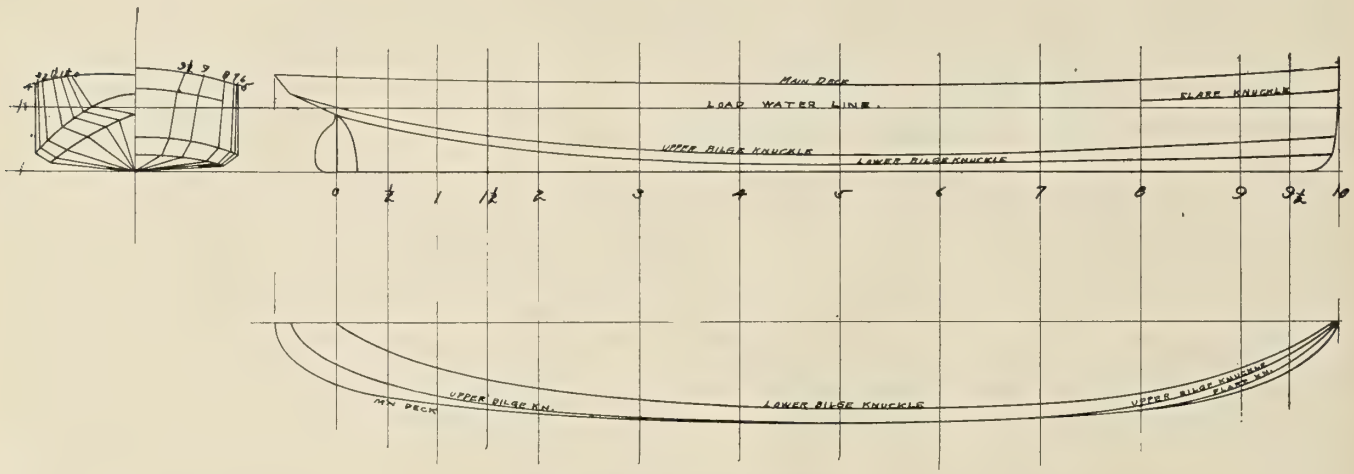
Steam is furnished by Scotch boilers at 190 pounds working pressure. The main and auxiliary condensers have a condensing surface of 2,400 and 1,000 square feet respectively. The usual auxiliaries and pumps are provided.

New Design of Freight Steamer

BY R. D. KARR

IN the present times of frantic, or rather intensive, construction of ocean-going bottoms of all kinds, the closest attention is being given to efficient expenditure of labor, time and material. Implements for handling material are of elaborate proportions and large capacity, routing of work is carefully thought out, machines of improved designs find an eager market in the many shipyards old and new, and the fabrication of steel and wood is carried out to the last possible step before assembly in the ship.

But are all these items most advantageously utilized? In the last analysis the speedy and economical construction of a suitable carrier of freight and merchandise on the high seas is the ultimate aim and sole purpose of all these hair-splitting efficiency methods. Now, beginning with this object in view and keeping it always before us, let us strike at the root and source of all evil—the original design and conception of a new cargo ship of reasonable size and ordinary requirements.



Lines of Simplified Freight Steamer

In Taylor's "Resistance and Propulsion of Ships" and from various other authorities on ships' form and resistance, we learn that the performance of a ship is not affected by the shape of the vessel's sections, but by the shape of the curve of areas and the relation of length to beam and draft. Also, that generally the most advantageous sections are U-shaped forward and hollow V-shaped aft with a fine entrance for the forward waterlines and an easy run aft to the propellers. For this reason the writer suggests that the form of the hull be made up of warped surfaces with straight line elements and curvilinear directices, the straight line elements to be in line with the square frames of the ship.

With this construction no bending slab would be needed for the frames. All the shell plates could be rolled in straight rollers to the correct shape, as there would be only a single curvature. There would be no more girthing of frames in the mold loft for the spotting of rivet holes, and there would be only three or four lines in the whole ship to fair. In calculating displacements it will be seen

that the sections will be simple trapezoidal shapes and easy to estimate.

It is the opinion of the writer that after towing a series of tank models, type curves could be obtained for varying speed length ratios, $\frac{V}{\sqrt{L}}$, to go with the correct load water-line that would obtain the required curve of areas on a given displacement. These data curves for the upper and lower bilge knuckles (see sketch) would give a definite ship form within an hour after "steam is up on the intergrator and the grease cups screwed down on the slide rule."

The outstanding feature of the new design is the bilge strake. This is of equal width or nearly so all fore and aft. It starts at the stem and running aft the upper edge widens out in the half breadth and at the same time dropping in the elevation in an easy curve. It thus forms the lower corner of the U-shaped sections, and running along amidships it corresponds to the bilge strake in present vessels. Following aft both edges rise in elevation in a gentle curve, and the lower edge runs inboard to meet the centerline of the ship at the stern frame. Meanwhile the upper and outer edge runs in around the stern under the main deck and corresponds to the legitimate knuckle in the present ships. There will, of course, be a knuckle line running aft from the stern frame on the centerline of the ship under the counter, but by the time it reaches the knuckle under the main deck the port and starboard bilge strakes will flatten out square across.

Examining the interior of this new boat, first of all the frames are straight. It will be necessary to cut some of them at the bilge strake and make the connections of the various lengths with large brackets. But, as can be seen from the body plan, most of the frames up forward and some of those aft can be bent at the knuckles without difficulty. The two knuckle lines at the bilge have strong fore and aft continuous longitudinals to provide connection to the adjacent shell plates. There will be no shell plating with a knuckle in it, but the plate edges will run along the knuckles on either side.

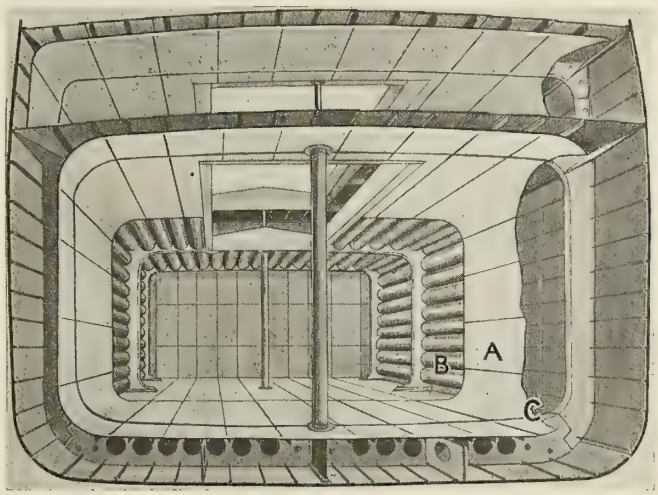
The longitudinals at the knuckles could be made deep and of special construction, affording considerable longitudinal strength, for it will be seen that the very run of the knuckles fore and aft gives an arched construction, and along with the continuous bilge strake plating the break in the continuity of the hull will be a source of strength rather than weakness, as is the case with the chine piece in V-bottom motor boats. The tank margin could land very neatly on the flat bilge strake, or, better, one of the longitudinals at the knuckles could form the margin plate. The flare-up forward could be obtained by running a knuckle line from the stem aft as far as necessary, and the frame could be bent here without difficulty.

From the foregoing it can easily be seen that the fabrication will be much simplified and speeded up. The whole construction will get a boat to the shipowner quicker than the present designs permit. At times like these, when the capacity of a yard is increased, everybody wins and nobody loses, for there is a crying need for all the tonnage that can possibly be built for several years to come. It is believed that the construction outlined above has several commendable and patentable features and steps are under consideration for the protection of all rights of the originator of the design.

Non-Sinkable Ship Proposed

Myron F. Hill, patent attorney, of New York, who recently made public a proposal to build ships of cast steel sections welded together by an arc-welding process, now proposes a new type of construction which may be applied to any type of steel ship, which, it is claimed, will render the ship practically unsinkable and thus effectively meet the submarine campaign against shipping.

The construction consists in having the sides, decks and bulkheads of the vessel lined with watertight air cells formed by welding thin sheet steel plates either to the inner edges of transverse frames, as shown at *A* in the illustration, or across the edges of longitudinals, as shown at *B*. The cells may be flat or arched and both systems may be combined—that is, large transverse chambers may



Section of Cast Steel Ship, Showing Thin Steel Plates Welded to Transverse and Longitudinal Framing, Deck Beams and Bulkhead Stiffeners, Forming Buoyant Cellular Structure to Prevent Sinking of Ship by Torpedo or Mine Attack.

be used for the machinery space and longitudinal chambers for the cargo holds.

Air cells formed of steel having welded joints, it is claimed, are safe from leakage, because to crack a welded joint a sharp bend of the material is necessary, which can occur only along the edge of a breech in the hull. While this air cellular construction can be applied most effectively to the cast steel ship construction proposed by Mr. Hill, nevertheless the system may be applied to ships of ordinary type, provided the riveted joints be welded sufficiently so that they will not be loosened by an explosion. If sufficient buoyancy is not provided by the cellular structure, watertight air containers, as described by Mr. William T. Donnelly in the June issue of Marine Engineering, could be included in the cargo.

The weight of the thin steel cellular construction, it is claimed, is not prohibitive, and its extra cost would be offset by reduced insurance premiums. It is also suggested that the cellular structure be connected to a supply of compressed air for driving out water in case any part of the structure is damaged by a torpedo or other means.

Largest Drydock in Argentina Completed

According to press dispatches from Buenos Aires, the largest drydock in Argentina, located at Puerto Militar, near Bahia Blanca, has been completed and successfully tested under the supervision of a board of officers of the Argentine Navy. Actual construction of the dock was begun in the latter part of 1911. Official tests showed that the pumping plant is capable of freeing the dock of water in seventy-five minutes.

STRAIGHT-LINED SHIP MODEL EXPERIMENTS

Ship-Shaped Models Developed from Experiments with Straight-Lined Forms

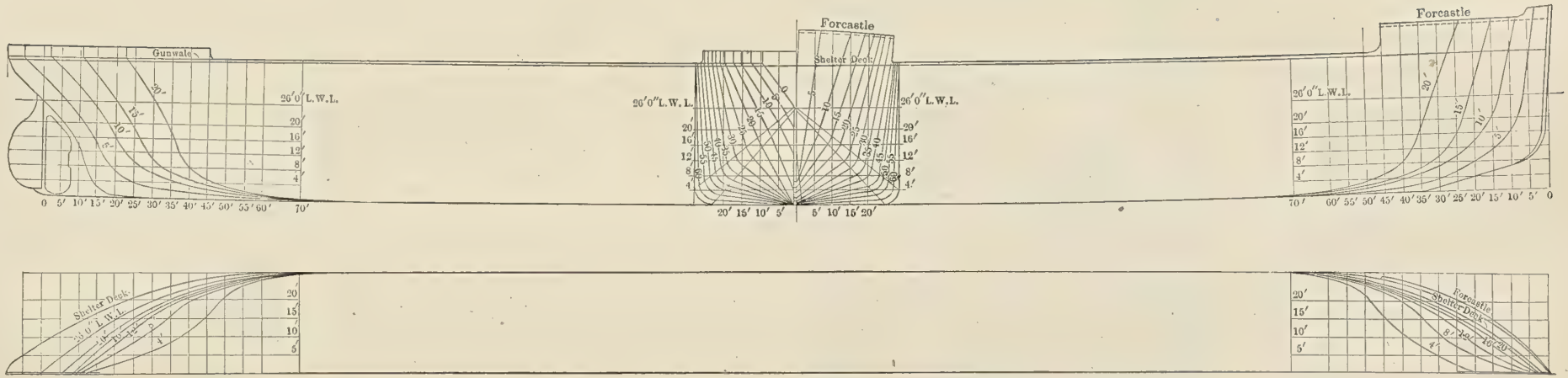


Fig. 1.—Proposed Emergency Single-Screw Steamer Type D. 410 Feet Between Perpendiculars by 55 Feet Beam by 37 Feet 6 Inches Depth Molded. Length of Fore Body, 70 Feet (17.07 Percent). Length of Middle Body, 270 Feet (65.86 Percent). Length of After Body, 70 Feet (17.07 Percent). Displacement on 26-Foot Load Waterline, 14,130 Tons. Block Coefficient, .844. Wetted Surface, 38,500 Square Feet

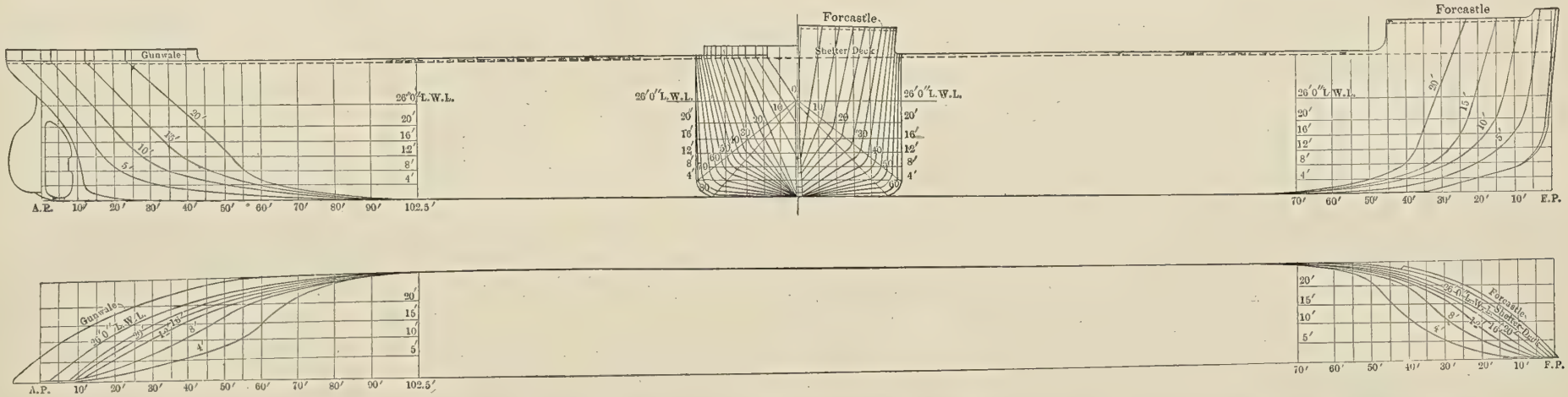
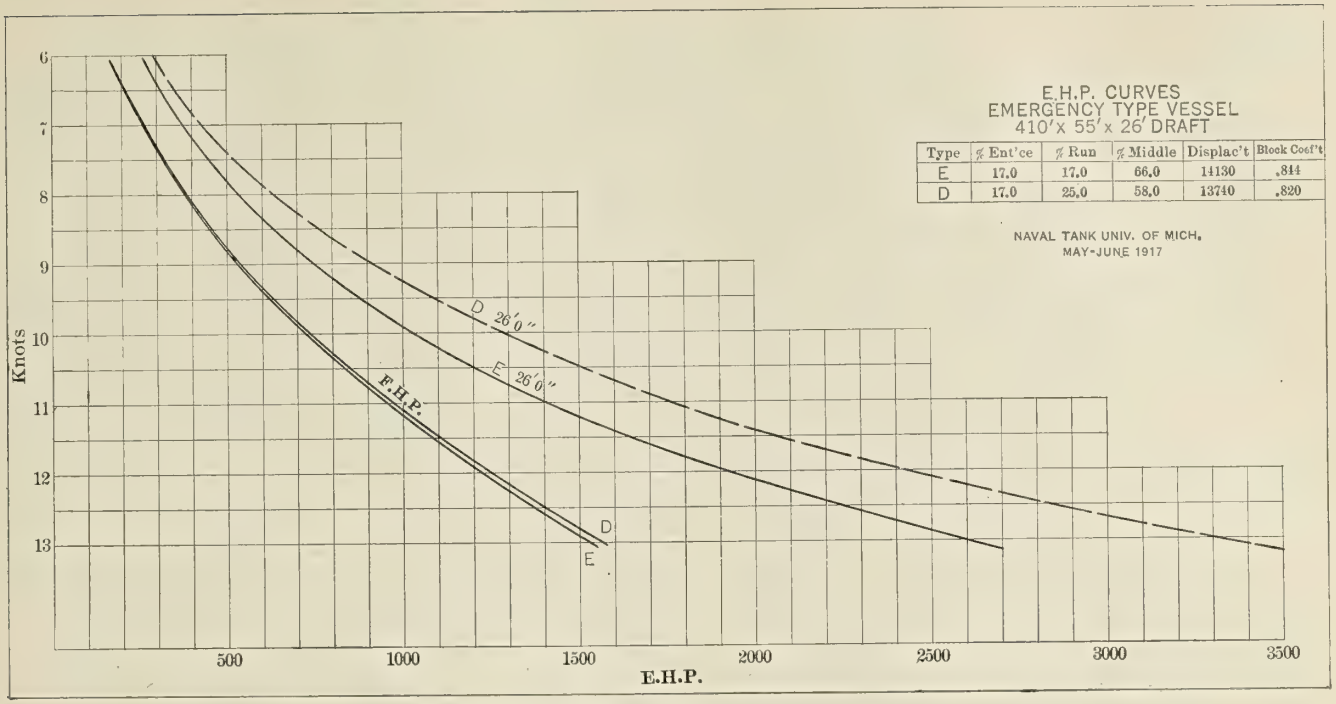


Fig. 2.—Proposed Emergency Single-Screw Steamer Type E. 410 Feet Between Perpendiculars by 55 Feet Beam by 37 Feet 6 Inches Depth. Length of Fore Body, 70 Feet (17.07 Percent). Length of Middle Body, 237 Feet 6 Inches (57.93 Percent). Length of After Body, 102 Feet 6 Inches (25 Percent). Displacement on 26-Foot Load Waterline, 13,740 Tons. Block Coefficient, .82. Wetted Surface, 37,840 Square Feet



Type	% Ent'ce	% Run	% Middle	Displac't	Block Coef't
E	17.0	17.0	66.0	14130	.844
D	17.0	25.0	58.0	13740	.820

Fig. 3.—E. H. P. Curves of Types D and E Steamers

Straight-Lined Ship Model Experiments

Investigation of Form of Seagoing Vessel Best Suited for Emergency Construction—Straight Line Hull Modified

BY ALBERT ED. SAUNDERS *

IN an endeavor to meet the present emergency caused by war shortage of tonnage, shipbuilders generally have been devoting their energies towards developing a vessel which would have necessary seagoing qualities, be economical to drive and at the same time be of the simplest possible form of construction; such form to follow straight lines to the limit of practicability in order that, if necessary, structural shops could fabricate the greater portion of the vessel's structure, leaving to the shipyard the erecting and the fabrication of the more complicated parts of the structure.

At the instance of Mr. J. Howard Pew, president, Sun Shipbuilding Company, Chester, Pa., the writer made designs embodying these ideas, and models were towed by Prof. H. C. Sadler at the University of Michigan experimental tank, for the purpose of obtaining the desired information as to the form of vessel best suited to the purpose in view.

The results of our investigations in the form of the vessel's lines, together with the speed and power data obtained, were presented to the Shipping Board early in June, for the benefit and guidance of those of the shipbuilding world interested, and particulars have also since been given to such yards as have approached the Sun Shipbuilding Company's officials on the subject, with the result, we hope, that the country is benefiting by the research undertaken.

A review of the work done will no doubt interest and benefit those shipbuilders who may wish to work along these lines, and who may not have already been informed on the subject.

For the purpose of obtaining the fullest information possible, a start was made by towing a model having straight lines in every direction. The bilge was rectangular, sides vertical and parallel for a greater part of the length, terminating in a V-shaped entrance and run; the keel at the stern cut up to considerable rake, and at stem only slightly (type "A"). This was followed by rounding the bilge to a radius and slightly rounding the shoulders (type "B"). The next step was to round the shoulders to a large radius and also to ease the knuckle where the keel left the base line to rake up aft (type "C"). As will be observed, the resistances of these forms of model were abnormal and not within the range of practical application. The first idea was to fit twin overhung rudders and a central strut for the propeller. From the observations made during these experiments, it was evident that a more shipshape form, with stern frame and a single rudder, was the more practical method of meeting this feature.

By coincidence, Prof. H. C. Sadler was also investigating along the straight line idea, and from the experience gained with the experiments already outlined, and the form suggested by Professor Sadler's ideas, new lines were designed, approaching more nearly ship form, but still retaining the straight line idea (type "D" and type "E").

The accompanying diagrams explain themselves as to form, and the speed and power curves resulting from the change in model were most encouraging, and indicated that as an emergency vessel such forms could be adopted to advantage. A comparison of these curves with those

* Naval Architect, Sun Shipbuilding Company, Chester, Pa.

STRAIGHT-LINED SHIP MODEL EXPERIMENTS

Data from Tank Experiments by Professor H. C. Sadler, at the University of Michigan

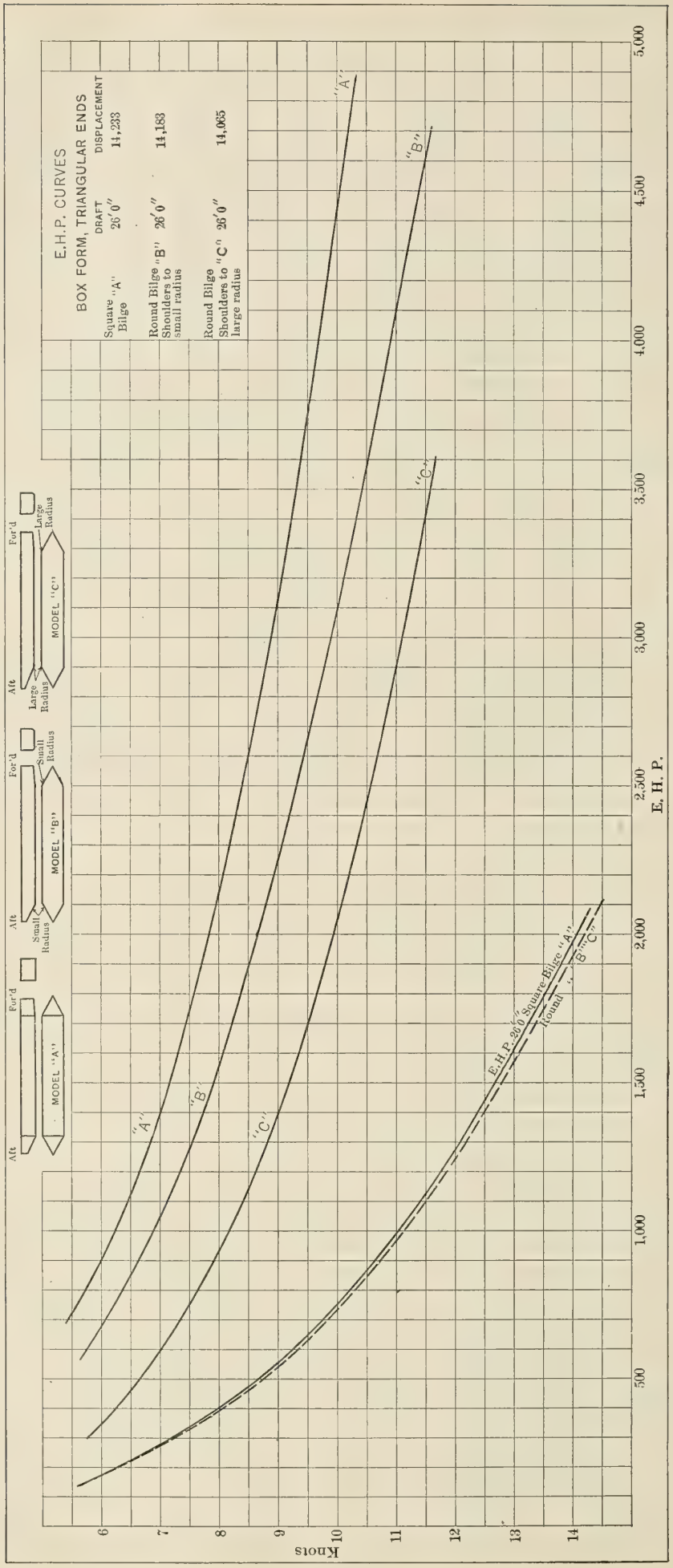


Fig. 4.—E. H. P. Curves of Box Form Models with Triangular Ends

for vessels of usual form and similar dimensions, and even somewhat finer block coefficients, will show up remarkably in favor of this form.

There will, of course, have to be considerably more strengthening in these vessels for pounding and panting than in the normal-shaped vessel presenting curved surfaces. It will be noticed that the length of the middle body may be considerably in excess of the generally accepted practice for similar block coefficients, all of which will materially assist in the simplification of structure and consequent speed of manufacture.

The writer feels greatly indebted to Prof. H. C. Sadler for his services in conducting the experiments, and also for the valuable advice given in general during the development of the various designs.

Professor Sadler has promised to treat this subject in a paper to be read before the Society of Naval Architects and Marine Engineers at its next meeting, when the whole series of experiments will meet with his analysis, and no doubt prove to be of value to the technical shipbuilding world. In the meantime, this matter is now given to assist, at the time when most needed, any shipbuilder who may be working along these lines.

The plates are lettered in the sequence in which the experiments were conducted, and will explain themselves without further comment at this time.

Width of Quay Terminals and Proportional Dimensions of Piers, Slips and Sheds for Inland Barges and Ocean Freighters

BY H. MCL. HARDING *

Quays are mostly confined to inland rivers or where there is available a long waterfront.

A pier may be considered as two quays placed back to back.

As to the following principles, there must be exceptions, as in cases where there is not sufficient land available, or the appropriations are not sufficient.

Quays

To attain the best results, the desired width or depth of the property for a quay terminal can be accepted as about 400 feet. For this width the space may be divided as follows:

	Feet
Frontage or the area between the face of the quay wall and the front of the shed	45
Steel shed width	60
Between shed and warehouse	60
Concrete warehouse width	80
Space rear of warehouse	55
Track space for car storage	100
	400

Where less width is available, as 250 feet, it may be advantageously divided as follows:

	Feet
Frontage	35
Shed	50
Between shed and warehouse	50
Warehouse	70
To the rear of warehouse	45
	250

Provision may be made for storage tracks at the end or ends of the terminals, or on some rear areas. Where there is even less area, the width of the shed may be reduced to 40 feet, and additional shed capacity can be economically obtained vertically and not horizontally. When there is less than 200 feet, the warehouse can be placed elsewhere, as to the rear of the open or coarse freight storage area. In this case the division can be:

	Feet
Frontage	35
Open storage area	40
Car tracks	35
Warehouse	70
	180

The above will serve to indicate, in laying out quay terminals, the area necessary for successful operation. Land to the rear of a public road, or of lines of railways, can be utilized advantageously for warehouses by installing carrier connections.

Piers

At basins of inland waterways it is often advisable to install piers on account of the water frontage being limited or for concentrating the terminal works.

If the pier be 350 feet in length to accommodate a barge 300 feet long, 40 feet wide, the width of the pier should be 125 feet; the slip, 180 feet wide; the shed, 300 feet long, 60 feet wide, and 30 feet clear height beneath the roof trusses. Provision is here made for four barges abreast.

If the pier be 675 feet in length to accommodate two barges, in tandem, on each side of the slip, and four abreast with a bargeway between for the barges, the width of the pier should be 150 feet, the slip 225 feet wide, sheds 300 feet long, there being two sheds in tandem, each 80 feet wide, 30 feet clear height below the girders.

For a pier 1,000 feet long the width of the pier should be 170 feet, the sheds (three) each 300 feet long, 80 feet wide, 30 feet high below the girders, and machinery for tiering and for transverse and longitudinal movements.

Conclusions

Pier, 350 feet long, 125 feet wide; slip, 180 feet wide; shed, 300 feet by 60 feet by 30 feet.

Pier, 675 feet long, 150 feet wide; slip, 225 feet wide; shed (two), 300 feet by 80 feet by 30 feet.

Pier, 1,000 feet long, 170 feet wide; slip, 225 feet wide; shed (three), 300 feet by 80 feet by 30 feet.

For ocean freighters at marine terminals the dimensions should be:

Pier, 600 feet long by 150 feet wide; slip, 250 feet wide; shed, 500 feet by 80 feet by 30 feet.

Pier, 1,200 feet long, 170 feet wide; slip, 350 feet wide; shed (two), 500 feet by 80 feet by 30 feet.

By making a shed 30 feet high its usual capacity can be trebled. This means that such a shed utilizing high tiering with 80 feet in width, is equal to a shed 240 feet wide, tiering 5 feet high.

The cost of mechanical handling, including tiering, 15 to 20 feet high, with the interest on the investment, maintenance and amortization, is less than the handling by manual labor, tiering 5 feet in height.

* Engineering Terminal Expert, New York State Barge Canal, New York.

New Ocean Terminals to be Built for Emergency Fleet

The Council of National Defense has created an advisory commission on terminal facilities to work with the General Munitions Board and with the special committee of the Board on Storage Facilities. Francis Lee Stewart, consulting engineer, formerly chief engineer of the Baltimore & Ohio Railroad, who represents the ports of Baltimore, will be chairman of the commission.

The committee is making a study of the ocean terminals of the country for the use of war supply vessels, and it is understood that new terminals are to be built especially for the assembling and loading of supplies for American ships abroad and for the Allies.

SALVAGING THE SESOSTRIS

Reclamation of Once Famous Kosmos Liner

Fig. 1.—*Sesostris* on beach at Ocos, Guatemala, Showing Relative Distance from High Water

Fig. 2.—*Sesostris*, as She Floated in the Lagoon Prior to Final Salvage Operations

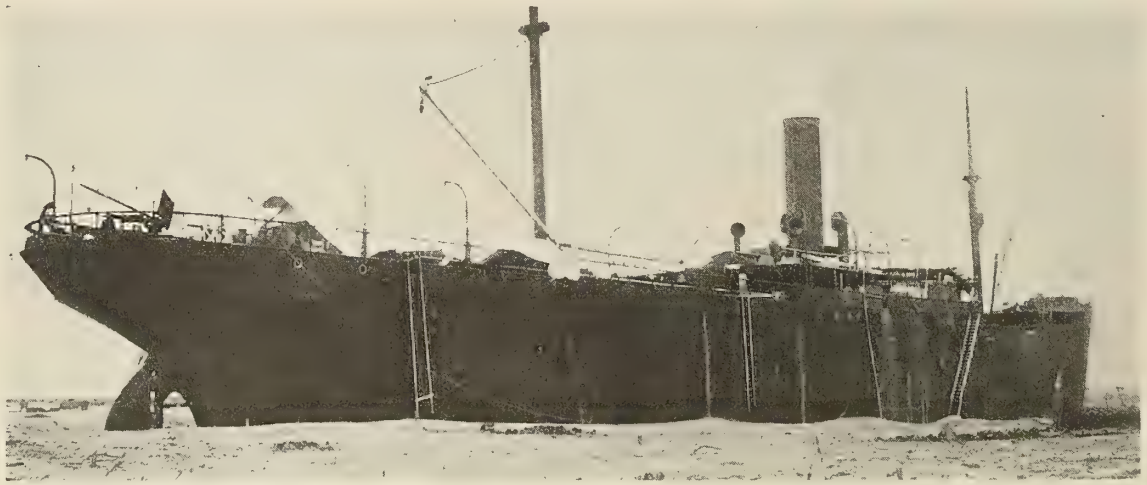


Fig. 3.—Side View of *Sesostris* Afloat in Lagoon. Water Not Visible in This Picture

Fig. 4.—*Sesostris* (*Presidente Estrada* C.) Just After the Final Salvage Dredging Operations Were Started

Fig. 5.—Portion of the Lagoon Giving an Idea of the Vast Amount of Sand Removed

Salvaging the Sesostris

Once Famous Kosmos Liner Reclaimed for Active Service After Ten Years at Rest on the Beach at Ocos, Guatemala

BY GILBERT C. DOHM *

POSSIBLY one of the most remarkable salvage operations ever undertaken on the Pacific Coast was brought to a successful termination by the Skinner Syndicate of Seattle, Wash., when on March 24, 1917, the former Kosmos liner *Sesostris* was again floated from her landlocked position in the sand of the beach at Ocos, on the west coast of Guatemala, where she had remained undisturbed for almost ten years.

Drifted Ashore on a Calm Night

On the night of September 15, 1907, while lying at anchor in the open roadstead of Ocos, Guatemala, and awaiting to take on a load of coffee, the ship suddenly became unshackled from her moorings and, swinging around broadside to the beach, gradually drifted ashore unbeknown to anyone on board. The high tide which was running at the time helped place her well up on the beach, but, contrary to general opinion, there was no storm or strong wind at the time; the water was smooth and a bright moon and ideal conditions prevailed and the unfortunate occurrence can be attributed to nothing but neglect on the part of the officers and crew, all of whom were apparently asleep.

Word was immediately sent to other ships of the Kosmos line plying in nearby waters, two responding to the call for assistance, but their efforts to float the *Sesostris* were futile.

Acted as a Breakwater

Acting as a sort of breakwater as she lay there, the shifting sands kept in motion by the surf and strong currents prevalent along that beach gathered about her and she was held fast. As time passed more and more sand gathered about, changing the actual contour of the beach for a considerable length and thereby placing her further and further inland, not by any actual movement of the ship itself, but by the formation of new beach about her. Before the final salvage operations were started she was about 200 feet up on shore from the high water mark.

For years the *Sesostris* was used as a landmark to guide mariners, and in many instances fixed their point of destination to take on a load of coffee from coffee houses at Ocos.

Abandoned by the Underwriters

After unsuccessful attempts were made to refloat her, the underwriters decided not to make any further attempts and she was sold on November 18, 1908, being purchased by a Spaniard named Bruno G. Mijares, of Tapachula, Mexico, from Oetlinger Gebrüder, of Hamburg, Germany, for $20,000 (£4,100).

Knowing the peculiarities of the beach at this point, it is believed that Mijares had hopes of the beach again changing and a high tide lifting her from her position. It is Mijares' claim that this actually happened once, but neglect on the part of the caretaker who was stationed on the ship to take up on the cables, which were fastened to anchors laid out a considerable distance in the sea to prevent her from going inland any further by her own movement, left her in practically the some position when the tide receded.

Previous stories about her being used as a hotel and lighting up the city of Ocos by electricity obtained from her own generators, are without foundation. It is, however, true that the ship was cared for and kept in an almost perfect state of preservation. When floated the machinery was well oiled and polished and the propulsive units and auxiliaries were in almost perfect condition, with the exception of the boilers, which required retubing.

Attempts Made to Refloat Her

Between the time that the *Sesostris* drifted ashore and the final successful salvage undertaking, a number of other attempts were made to refloat her which, for one reason or another, simmered into failures. The first of

* Associate Member, Society of Naval Architects and Marine Engineers.

these attempts was made in 1912-13 in the name of the Philadelphia Breakwater Company, but it is alleged that it was not actually a Philadelphia Breakwater Company's undertaking. After this attempt had failed the ship reverted to her former owner, and the enterprising Mijares rigged up the pumps which were left and started operations of his own by dredging the sand which had formed about her, and actually causing a lagoon to be made by the water which seeped through the sand from the sea, and in which a slight movement of the ship was perceptible. But he, too, gave up the task owing to his interests

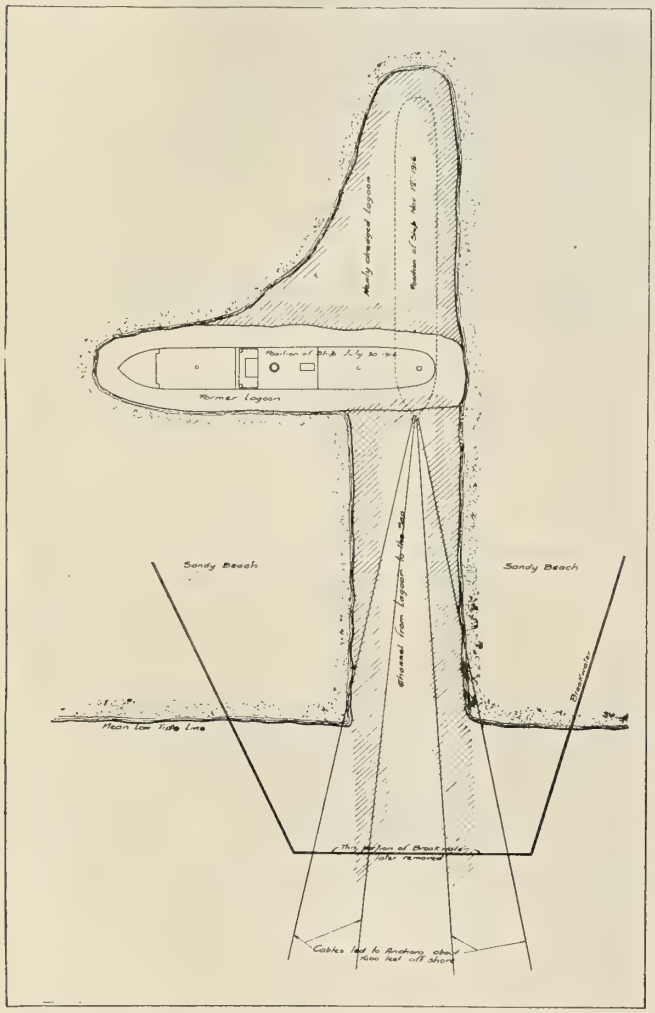


Fig. 6.—Plan Showing Position of *Sesostris* Before Salvage Operations Were Started and Position to Which Ship Was Pulled Before Being Drawn Seaward. Portion Within Shaded Area Was Dredged Under New Operations.

in Mexico requiring all of his attention with the advent of the revolution.

Option on the ship was held for a short time by the Luckenback Steamship Company, of New York City, which after its expiration was obtained by Mr. Joseph Thebaud, who, early in 1916, interested Mr. D. E. Skinner, president of the Skinner & Eddy Shipbuilding Corporation, Seattle. Mr. Skinner, in turn, took the matter up with a number of his friends. After a thorough investigation was made, due to the present great demand for ships and the consequent high cost of tonnage, the Skinner Syndicate was formed. In conjunction with Mr. Thebaud, preparations were at once made towards salvaging this once famous ship. Surveyors were sent to inspect the condition of the hull, machinery and fittings, and a metallurgical test was made at Guatemala City on portions of the steel. So favorable were their reports that arrangements were at once made with the British Columbia Company to undertake the salvage work.

On July 30, 1916, the salvaging crew was landed from the salvage tug *Pilot* at Ocos, and on August 16 dredging operations were started on the lagoon, or artificial lake in which the ship was first floated, for the purpose of extending it in a way to permit the ship being turned and headed straight into the sea. Previous operations made by the other company in its attempts and by the owner himself had caused a partial lagoon to be made. The new operations necessitated the dredging of a considerable amount of sand, approximately 100,000 cubic yards, on the starboard side of the stern end of the ship and at the southerly end of the already present lagoon. It was also necessary to dredge out portions of the already present lagoon in order to deepen it and give better flotation to the ship. Fig. 6 shows the position of the ship on July 30 and the lagoon in which she lay, the part within the hatched area being that portion which was afterwards dredged under the new operations.

Final Salvaging Operations

There were three centrifugal pumps used when the dredging operations were first started. One 8-inch pump was placed on the sand alongside the lagoon and two 10-inch pumps were placed on a barge which was floated in the lagoon alongside the ship. The discharge piping was led to the land on trestle work, which in turn was erected on barges and floated in the lagoon. With each new movement of the ship the discharge lines were broken and replaced to suit the new condition. Steam was furnished entirely by the ship's main boilers, there being no donkey, and most of the fuel used was wood obtained from nearby forests.

The task of dredging the lagoon was completed on November 12 and the ship was brought around head-on toward the sea (Fig. 6). Work was then started on dredging a channel from lagoon to the sea, and on November 26 the first of a series of setbacks was experienced when the ridge of sand which protected the lagoon from the sea, and which had become narrow, weak and undermined, due to the dredging operations, was washed in by the heavy surf and strong currents running, threatening to fill the lagoon and channel with every high tide.

Construction of Breakwater Necessary

A rough barrier was immediately constructed which proved unsuitable, and it was decided to build a breakwater completely enclosing the bow of the ship, which afterwards proved indispensable. This was done by driving logs and sinking steel sheet piling into the sand for a depth of about 15 feet by means of a water jet (Fig. 8) and carrying this construction out into the sea as far as it was possible to work at low tide. The sheet piling was left there on the beach from previous operations, and, together with the timber, formed a fair protection, the whole being braced and shored up in the rear. Provision was made to remove that portion in front of the bow to permit the ship to pass through when operations had advanced that far.

Many Other Difficulties Encountered

Aside from the difficulties experienced in the actual salvage operations, many other obstacles arose which materially handicapped the progress.

There was no landing place along that sandy beach for many miles, and therefore all the apparatus, tools, food, etc., had to be transferred to small, open boats and brought to shore in that manner. This method had its disadvantages when the heavy surf and strong currents were running and had to be postponed at times, often

SALVAGING THE SESOSTRIS

Reclamation of Once Famous Kosmos Liner

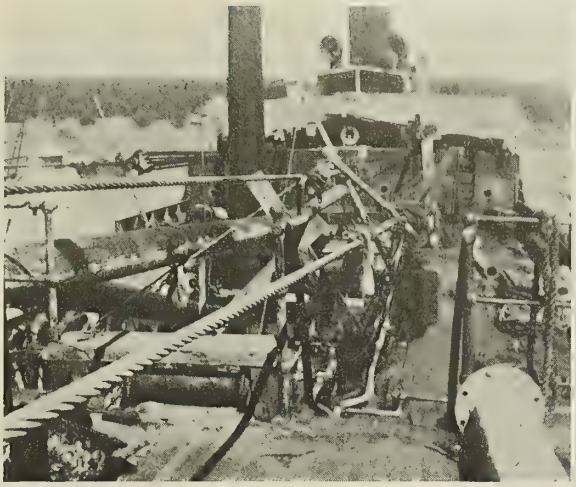


Fig. 7.—Deck View While Salvage Operations Were in Process. Tautness of Wire Cables Shows Strain Exerted.

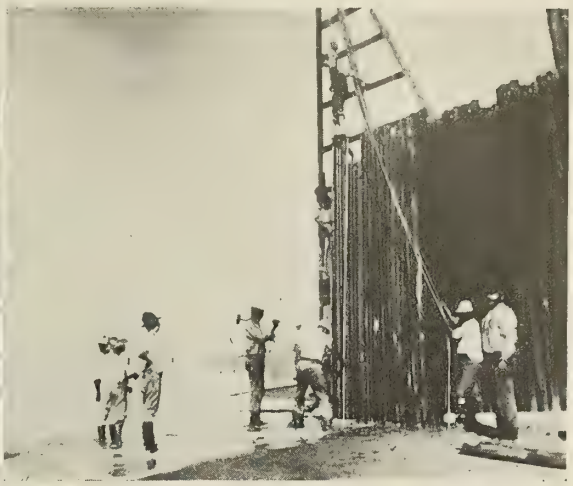


Fig. 8.—Building a Portion of the Breakwater

Fig. 9.—Showing Ridge of Sand Which Protected Lagoon From the Sea and Which Was Afterward Washed Away by the Surf.

Fig. 10.—Vessel Being Pulled Out of Hole in Breakwater

Fig. 11.—The *Sesostris Entering the Breakers*

Fig. 12.—*Sesostris* Awaiting a High Tide for Further Progress

causing many days' delay, for the loss of any portion of the outfit, all of which was brought from the United States, by the overturning of a boat did not warrant the risk of transporting in heavy weather.

During the day the heat was intense and at night the conditions were not much better, the sand radiating at night what the sun had given up during the day. The crew was therefore housed in improvised shelters on the deck of the *Sesostris*.

Fuel was also scarce and only wood was available at times. This was obtained from drift which came ashore and from nearby forests, where it was contracted for with the natives, who were often sceptical of the representatives' good intentions and had to be handled carefully. The hauling from the forests was done on cars run on temporary tracks which led up to the vessel.

Money with which to pay the crew was also hard to get, as there was none at all in Ocos, and therefore it was necessary for the paymaster to go to Guatemala City and get it there, the trip from here to Ocos and thence across the sandy wastes to the ship being made under heavy guard.

The commissary department, too, had its disadvantages, the galley on the ship serving as the kitchen. The drinking water was obtained and used only after passing through a series of filters.

However, these disadvantages were all well borne, and by sheer grit and perseverance on the part of all concerned the task was afterwards brought to a successful conclusion.

Tidal Data

As the plans for getting the ship off the sands were arranged according to the data obtained from the United States Coast and Geodetic Survey Tide Tables, a tide gage was constructed and placed in the lagoon. The tides were noted and a comparison with the values given in the tables was made, the two values in many instances varying as much as 40 percent. The gage itself finally became useless, due to the gathering of sand around it, making it impossible to read the figures, and the tide levels were then checked from the draft marks on the ship. The fact that real high tides only occurred three days in each month necessitated a well-planned program beforehand, so that advantage could be taken of every moment available.

Laying Out of Anchors

By December 4 four anchors had been laid offshore some 1,600 feet, and the cables, led through seven advantage tackles to the ship's own winches, fastened. The steel wire cables from the anchors were led to heavy steel blocks, which in turn were connected by 12-inch manila hawsers to every winch on the ship, thus distributing the strain over a number of points. An idea of the tension

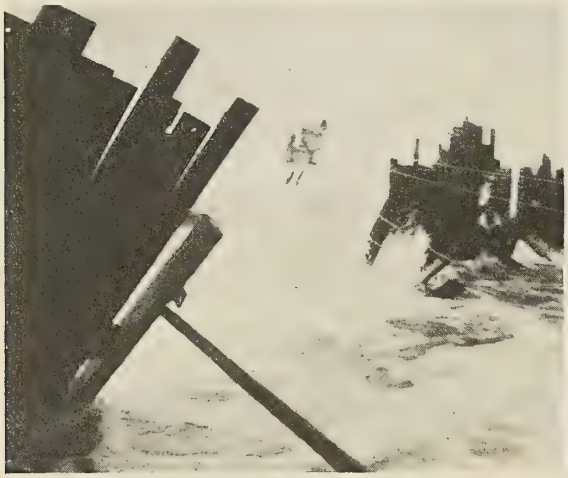


Fig. 13—Wreck of the Breakwater After Earthquake Shocks and Surf Had Demolished It

Fig. 14—The *Sesostris* Well Out Into the Breakers and Partially Waterborne

Fig. 15.—*Sesostris* (*Presidente Estrada C.*) Afloat at Sea

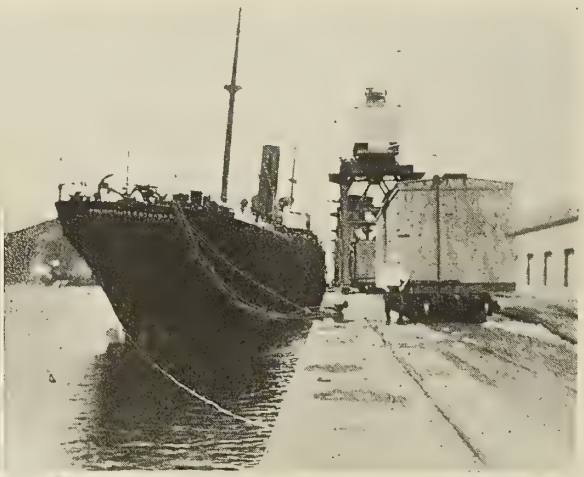


Fig. 16—*Sesostris* (*Presidente Estrada C.*) at Salina Cruz

SALVAGING THE SESOSTRIS

Reclamation of Once Famous Kosmos Liner

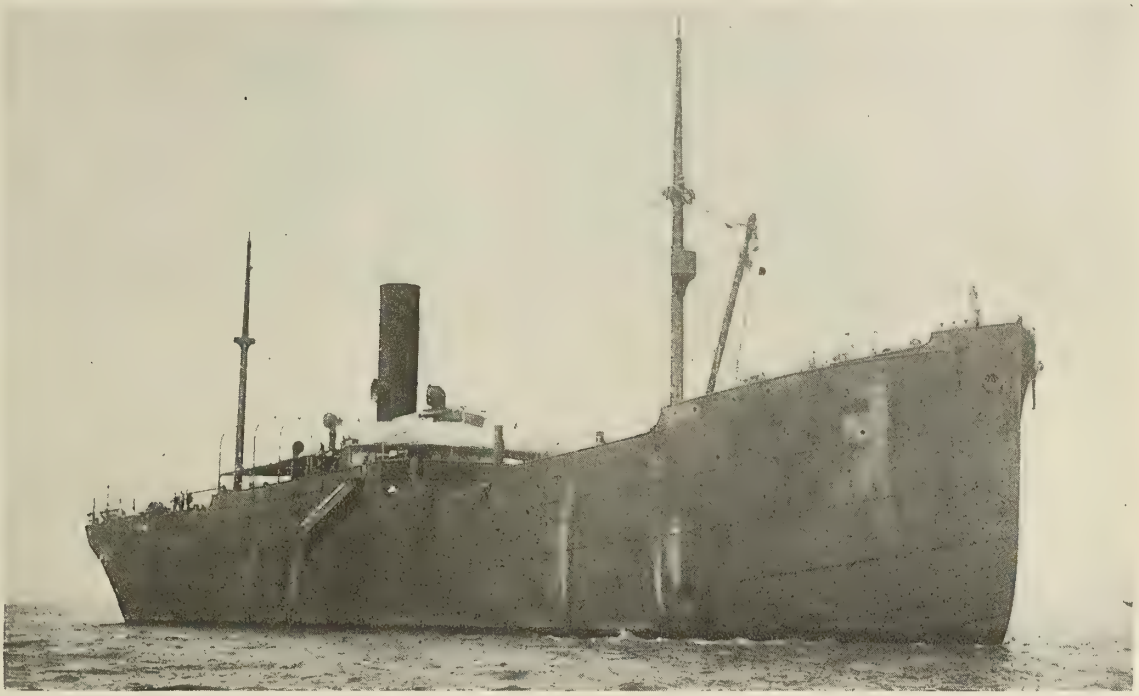


Fig. 17.—*Sesostris* (*Presidente Estrada C.*) Nearing Dock at Skinner & Eddy Shipyard, Seattle, Wash., Under Her Own Power

Fig. 18.—Deck View of *Sesostris*, Taken Immediately Upon Arrival at Seattle, Showing Almost Perfect Condition of Hull and Deck Fittings

created in the cable may be obtained from Fig. 7, which shows the elimination of all sag and the general taut appearance.

The first movement of the vessel toward the sea was also accomplished on December 4. As the task still ahead consisted of dredging out forward of the ship and discharging aft, the pumps were then taken off the barge and sand and with the addition of another 10-inch pump, placed on a platform built in the square of the hatch in the orlop deck. Two holes were cut in the shell on either side of the bow to admit the suction tubing to be run out and the discharge was carried up to the 'tween decks and led through the bulkheads and then overboard.

Movement of the Ship Towards Sea

Progress continued until by December 29 a total movement of about 170 feet had been accomplished. On this day another series of setbacks occurred when one of the anchors lost grip and started to draw towards the ship, and on another line the tackle line collapsed, due to the strain in the cable.

In the meantime the heavy surf and strong currents were running and the breakwater was being continually undermined and battered down, necessitating constant attention and repair.

From December 29, 1916, until January 21, 1917, no advance in the movement of the ship was made, the time being spent in preparing the breakwater for better service and getting things in readiness for a quick drive toward the sea.

On January 22, with the help of a full moon and consequent high tide, a new advancement of 20 feet was made, and for six consecutive days a total advancement of 120 feet was accomplished.

The Breakwater Collapses

On February 1 a severe earthquake shock was experienced and the strong surf and currents showed their weakening effect on the breakwater, which again partially collapsed, but was replaced. This same series of events was repeated on March 5, when intermittent shocks, lasting throughout the afternoon, so weakened the breakwater that on the following day it completely collapsed and was abandoned.

It had, however, served the purpose for which it was intended, for the ship by this time had been hauled to such a position that at extreme high tide partial flotation was possible. Dredging out forward of the ship, however, still continued, and due to the partial flotation at high tide large advances were accomplished when intermittent swells made her waterborne.

Ship Finally Afloat

During the high tide of March 24, 1917, at 3.30 P. M., the *Sesostris* was finally floated, having been pulled seaward a total distance of approximately 500 feet. She was then swung to anchor and proceeded to Champerico on March 25, where she anchored in the harbor, having made the trip from Ocos without assistance.

From here the trip continued northward to San Diego, Cal., a short stop having been made at Salina Cruz for fuel, with the C. P. R. tug *Nitinat* as convoy. At San Diego coal was taken aboard and the trip to Seattle continued, arriving at Victoria, B. C., on May 14, and being convoyed by the tug *Salvor* from Victoria to Seattle, where she steamed up to the wharf of the Skinner & Eddy plant on May 16, the entire trip from Ocos to Seattle having been made under the ship's own power.

Survey Reveals No Disintegration

A thorough survey of the machinery and hull revealed no disintegration. The wood decks and deck fittings and very much of the exposed parts were, however, weathered to some extent and a complete cleaning and overhauling were at once given. New wood decks were laid, all fittings were made standard and brought up to date, and the general arrangement changed, doing away with all passenger accommodations and thereby increasing the cargo space. She is now engaged in Oriental trade.

The *Sesostris* was built in Flensburg, Germany, by the Flensburger-Schiffsbau-Gesellschaft in 1897, and was operated under the name of *Octavia* until she was bought by the Kosmos line, when the name was changed to *Sesostris.* This name she still carried on her ill-fated voyage, but shortly after the Skinner & Eddy Syndicate started to salvage her the name was changed to *Presidente Estrada C.,* in honor of the President of Guatemala. Upon being registered under the United States flag she was rechristened *Frances L. Skinner,* and by that name she will be known hereafter.

She is 378 feet 10 inches long, 48 feet beam, 29 feet depth and about 24 feet 7¾ inches load draft, with a deadweight of approximately 7,300 tons.

When drifted ashore she was bound from San Francisco to European ports via the Straits of Magellan.

The remarkable feature about this ship is the fact that on account of the good care she received at the hands of her owner, no serious disintegration occurred; but still she was left unhampered, no salvage company making any serious effort to reclaim her, though many attempts were made and considerable money spent before the Skinner Syndicate took the matter in hand and successfully accomplished the task.

The writer is indebted to Mr. Joseph Thebaud for the pictures and facts contained in this article, and to Mr. D. E. Skinner for permission for its publication.

Unique Method of Launching

THE 2,000-ton steamship *City of Tampa,* built by the Merrill-Stevens Company in their Jacksonville, Fla., plant, was recently launched in what is probably a a very unusual way for a ship of her size.

In building a ship of this size there was no available berth at the plant for launching in the usual method without great inconvenience and expense. The vessel was therefore built with level keel abreast the company's 4,500-ton floating dock, about three-fifths of her keel on solid ground and the balance on an approach pier to the dry dock. Before laying the keel extra piling foundations for keel and launching ways were put down, making the pier portion as solid as the ground part.

When the hull was ready to launch, the ground ways rollers and cradle timbers of a dismantled 1,200-ton marine railway from the company's South Jacksonville plant were utilized. The ways were laid under the vessel in the usual manner, but with only about one-twentieth inch pitch to the foot. The ground ways were continued from the pier to the dry dock and the alinement checked by four sights on each side, two on the dock and two on the shore.

The vessel was moved by means of a twelve-part ¾-inch wire rope tackle operated from the hoisting drums of the company's 1½-yard clam shell dredge which was moored against the farther end of the dock.

When all was ready the ground ways were brought into perfect alinement by trimming the dock with its pumps, and the vessel moved easily as soon as the strain was brought on the tackle. When about 50 feet of the stern of the vessel was over the outriggers of the dock, she was stopped and the dock compartments directly at the end

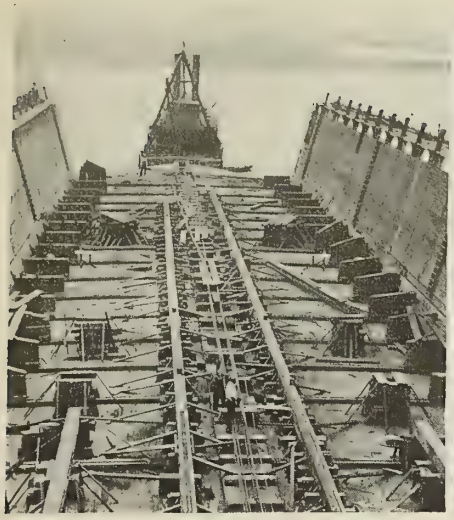


Fig. 1.—Dry Dock, Showing Tackle and Dredge in Position for Pulling

Fig. 2.—Dry Dock, Showing Sights Used for Checking Alinement of Dock, Also Dredge in Position for Pulling

pumped out until the ways were about ½ inch high. She was then again hauled about 50 feet, or until the sights showed about ½-inch sinking of the dock, then stopped until the pumping caught. This was repeated, more compartments of the dock being pumped as the vessel came over them, until in ninety minutes from the start she was entirely within the floating dock. She was then chocked and the ground ways connecting from the dock to the pier removed, and the vessel floated by sinking the dock in the usual manner.

The critical part of the operation, of course, lay in the fact that the vessel was moved off of solid ground on to a floating platform, which had to be kept adjusted to a constant alinement, despite increasing load from one end

Fig. 3.—Placing the Tackle and Rollers in Position

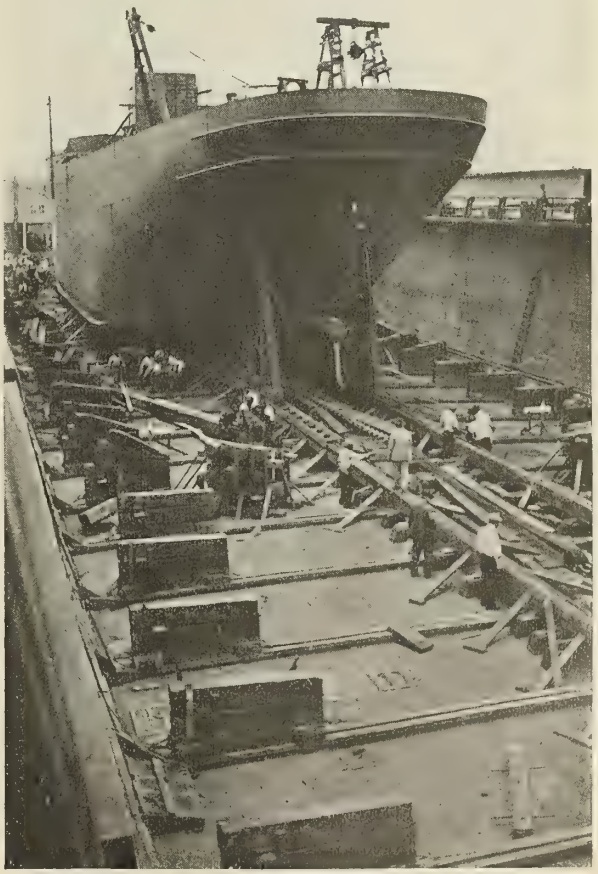


Fig. 4.—S. S. *City of Tampa* Partially in Dock

Fig. 5.—Where the *City of Tampa* Was Built, Showing Restricted Space for Launching

Fig. 6.—Vessel on Dry Dock After Transfer from Building Ways

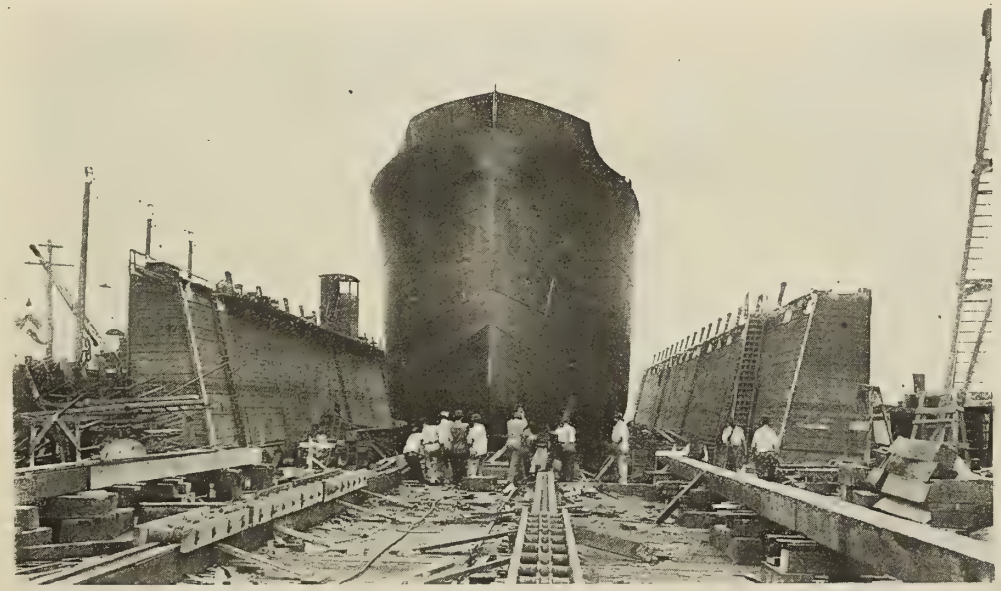
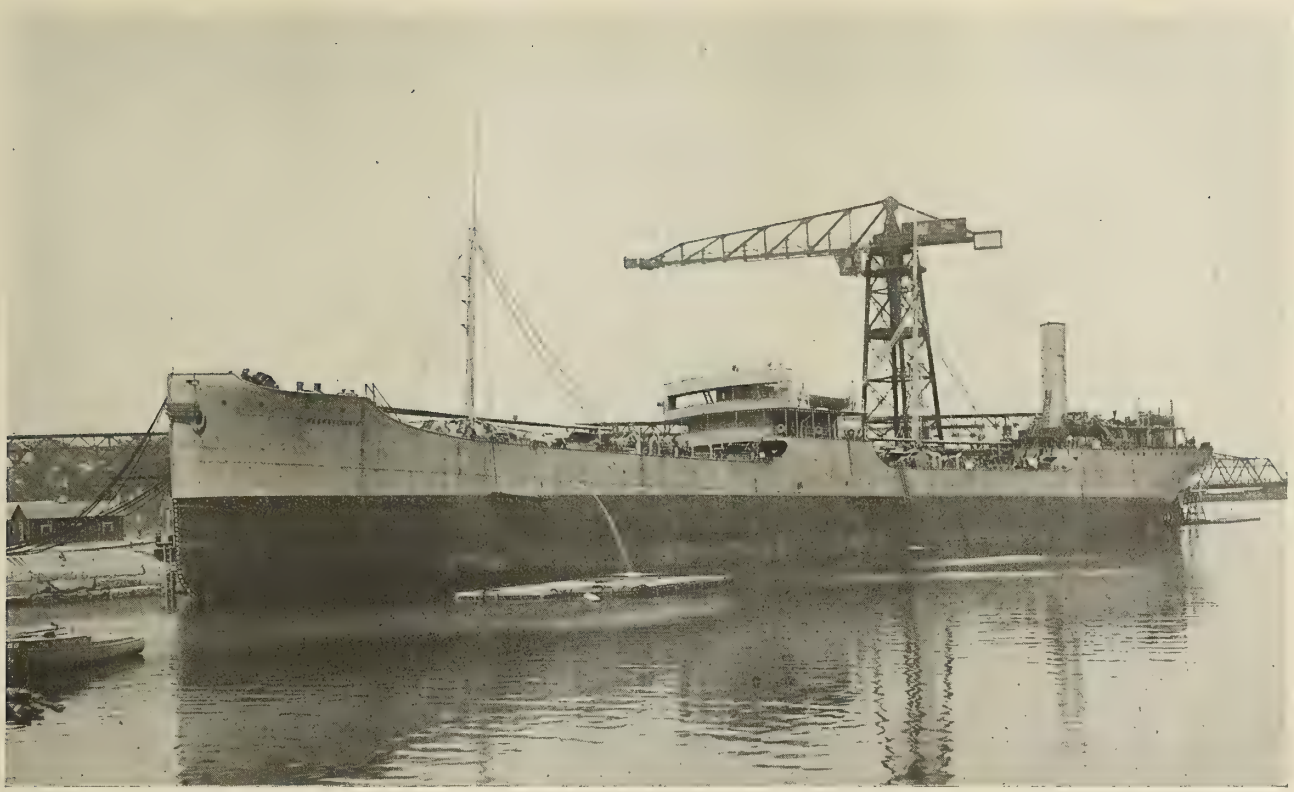


Fig. 7.—Gang Breaking Connection Between Dock and Ground Ways

Fig. 8.—The S. S. *City of Tampa* After Launching



Oil Tanker *Pennsylvania* Built by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Texas Company, New York. Launched on June 9 and Delivered to Owners on July 1

and changing tide level. This was made easily possible by the construction of the dock, the body of which is divided by steel bulkheads into sixteen independent compartments without interconnecting limbers, and each with its own sinking inlet and discharging pump. On this account it was not difficult to take up the weight of the vessel as she came over the dock by pumping the compartments directly under her. At the beginning only two end compartments were pumped, increasing as she advanced until at the final pull twelve were being emptied.

The operation was a perfect success, the vessel moving easily, showing no strain either on vessel or gear, nor at any time was the trim of her dock more than 1 inch out of perfect alinement. The actual pulling did not occupy more than fifteen or twenty minutes. The balance of the time was taken in stopping while the pumps were trimming the dock.

The *City of Tampa* is a hurricane deck, steel freighter, 221 feet long, 38 feet beam and 26 feet deep. Her keel was laid last September.

Twin-Screw Molasses Tank Steamer *Liborio*, One of Three Sister Ships Built by the Merrill-Stevens Company, Jacksonville, Fla., for the Cuba Distilling Company

Rush of Work at Fore River Yard

As an indication of the demand for carriers of all descriptions, and the pressure at which the Fore River Shipbuilding Corporation is now working to turn out the vessels it has under construction, the *Pennsylvania,* a tanker nearly 450 feet in length with a deadweight capacity of 9,100 tons, launched as recently as June 9, was on July 1 placed in commission and delivered to her owners, the Texas Oil Company of New York.

The Fore River Shipbuilding Corporation is steadily increasing its momentum. The number of men employed, working in night and day shifts, is gradually nearing the 7,000 mark and every facility is given them for the best of working conditions in every direction. President Joseph W. Powell states that in a few weeks he expects to have about 11,000 men, both skilled and unskilled, engaged in the yard.

In addition to merchant work there is under construction at this yard one-half of the submarines and one-third of the destroyers building for the U. S. Navy.

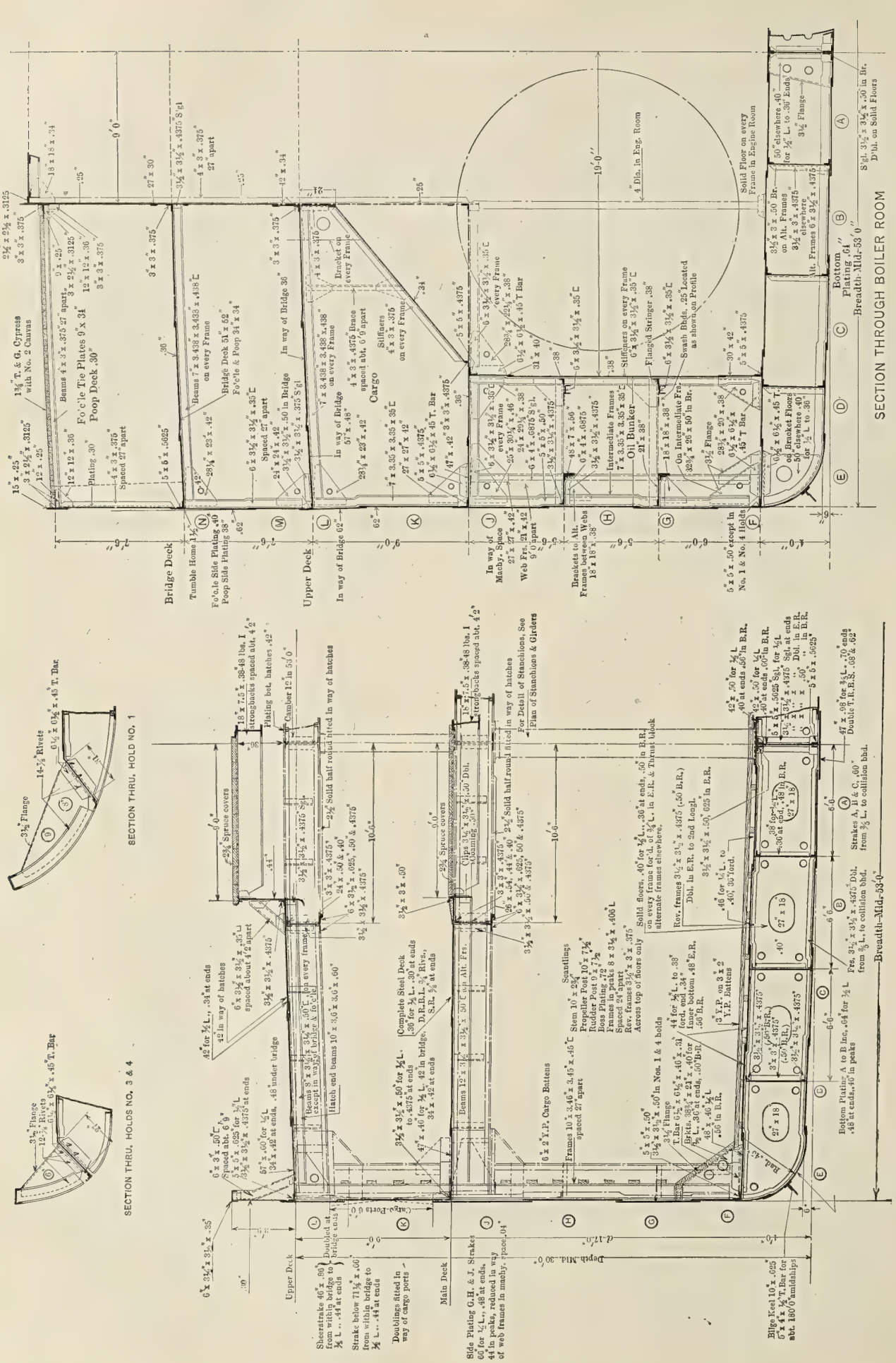


Fig. 1.—Midship Section and Section Through Boiler Room of Standard Steel Steamship for United States Shipping Board Emergency Fleet, Showing Scantlings

Standard Single-Screw Steel Steamship for U. S. Shipping Board's Emergency Fleet

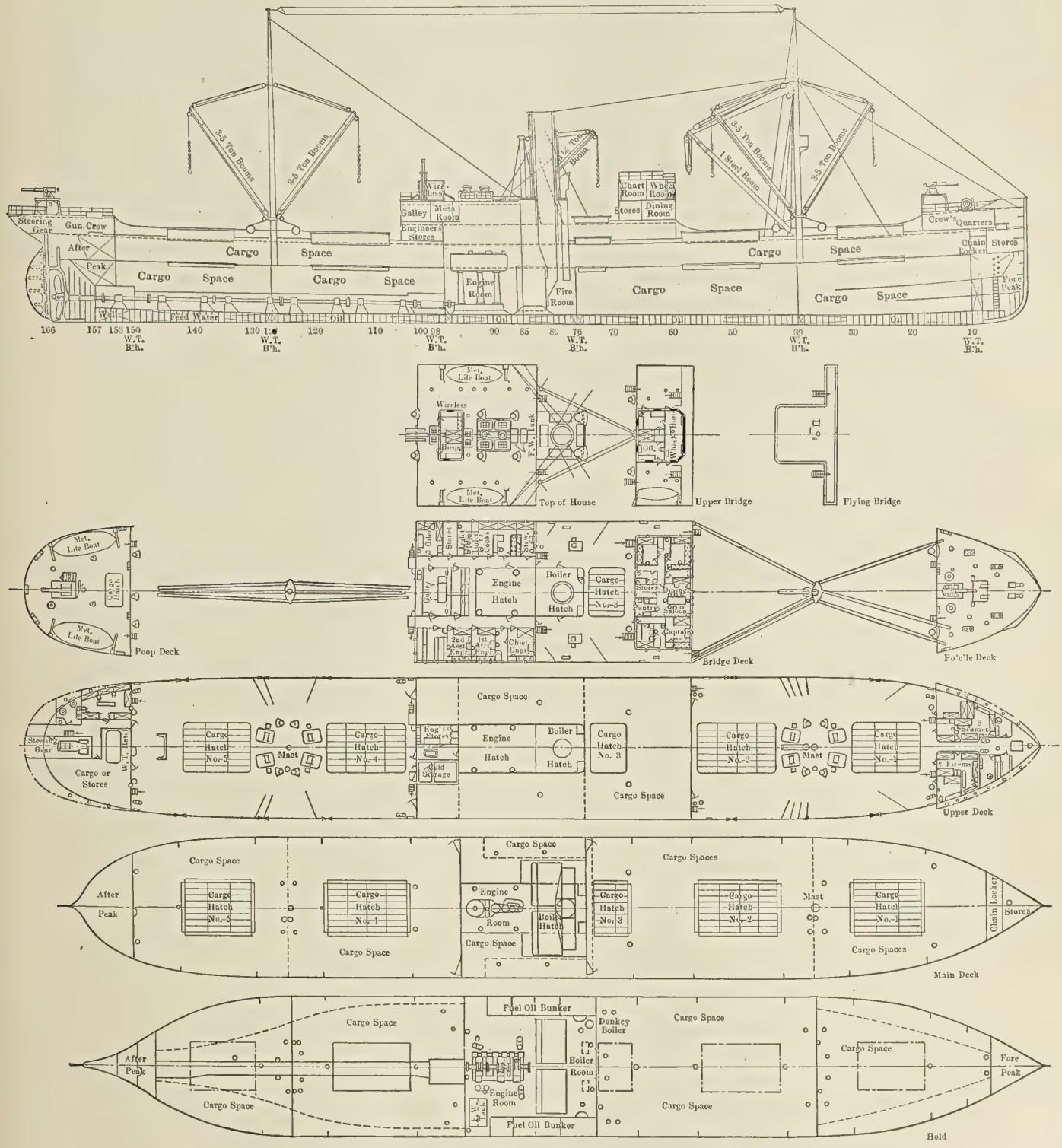


Fig. 2.—Profile and Deck Plans of Government Standard Steel Steamship

PLANS and specifications for a standard single-screw steel cargo steamer of 7,300 tons deadweight capacity and 11½ knots sea speed have been issued during the past month by the United States Shipping Board Emergency Fleet Corporation, in accordance with which the majority of the Government steel ships will be built. These plans and specifications have been worked out by the Shipping Board's naval architect, Theodore Ferris, 30 Church street, New York.

The vessel is of the single-screw type with straight stem and elliptical stern, schooner rigged with two steel pole masts. The hull is built on the transverse system

with two steel decks and a raised forecastle, long bridge and a full poop. At the forward end of the bridge deck is a steel deck house containing the officers' quarters, and the top of this house is carried to the sides of the vessel to form the upper bridge deck, on which is located a wooden pilot house with a flying bridge fitted at the level of the top of the pilot house. There is also a steel deck house containing the engineers' quarters, etc., built abreast the engine casing on the bridge deck. A wooden deck house, containing a hospital and wireless room, is located on top of the latter house.

A complete double bottom, subdivided into five compartments longitudinally, is fitted throughout the length of the vessel. The compartments under the machinery space and under holds Nos. 1, 2 and 3 are arranged for storing fuel oil, while the compartments under hold No. 4 are arranged for feed water.

Six watertight bulkheads divide the hull into seven watertight compartments; four of the bulkheads extend to the upper deck and two to the main deck. Cargo is handled through five hatches in the upper and main decks and one cargo hatch in the bridge deck. There is also a hatch in the poop deck and one under it in the upper deck to the after peak. The hatches are all 18 feet wide: Nos. 1 and 5 are 24 feet 9 inches long; Nos. 2 and 3, 29 feet 3 inches long, and No. 3, 12 feet 8 inches long. Four cargo ports, each with a clear opening of about 7 feet 8 inches by 5 feet 8 inches, are also fitted on each side of the vessel between the upper and main decks.

For handling the cargo, three wooden booms of 5 tons capacity each and two single-drum, single-geared winches are fitted on each of the hatches Nos. 1, 4 and 5. For hatch No. 2 there are three wooden booms of 5 tons capacity each, one steel boom of 30 tons capacity, and two single drum compound geared winches. For hatch No. 3 there are two booms of 1½ tons capacity each and two single-drum, single-geared winches.

The principal dimensions of the hull are as follows:

Length overall, about	385 feet
Length between perpendiculars	370 feet
Beam, molded	53 feet
Depth, molded, to upper deck	30 feet
Designed load draft, about	24 feet
Sea speed, loaded	11½ knots
Tonnage coefficient, about	.78

The tonnage, according to American Bureau of Shipping dimensions, figures out as

Under deck	4,400
Superstructure	340
Superstructure	125
Total	4,865

General Arrangement

As can be seen from the plans, the machinery, which consists of a triple expansion reciprocating engine driving a single screw, is located amidships with two main boilers abreast and a screen bulkhead built around them at their after end to separate the boiler and engine rooms. Side bunkers for fuel oil are fitted below the main deck in the engine and boiler rooms, in addition to the double bottom compartments arranged for oil storage.

Accommodations for the captain, deck officers, engineers, etc., are provided in deck houses on the bridge deck. Quartermasters, boatswain, mess boys, seamen and firemen are berthed in the forecastle. Quarters for the gun crew with wash room are provided in the poop.

The vessel is equipped with an electric lighting plant of 15 kilowatts capacity, a refrigerating plant consisting of a 1-ton direct expansion ammonia machine, steam heating system, steam steering gear, steam windlass and steam capstan. For defense against submarine attack two guns are mounted, one on the forecastle and the other on the poop.

Hull Construction

The framing of the vessel is on the transverse system with two steel decks in the hull. The decks are supported by girders and deep beams with one row of wide-spaced pillars. The side frames are cut and bracketed at the main deck in way of the bunkers, so that the lower bunkers may be made oil tight. All scantlings are as indicated on the midship section.

The stem is a flat steel bar made in sections and the stern frame is of cast steel in one piece.

Complete steel decks are fitted on the main and upper decks, bridge and poop and stringers and tie plates on the forecastle. The main deck is carried through in way of the machinery casings and is oil tight over the bunkers.

In addition to the six watertight bulkheads, steel bulkheads are fitted at the forward and after ends of the bridge and the forward end of the poop and around the quarters in the forecastle. The galley and crew's mess room inclosures are of steel, as are also all bulkheads inclosing quarters in the forecastle.

Side bunkers are fitted in the engine and boiler rooms. A fresh water tank of 8,000 gallons capacity with two compartments is located in the lower engine room, fitted with all necessary filling and air pipes and necessary suctions.

Four 24-inch ventilators are fitted to the engine room and two 42-inch ventilators to the boiler room, with turning gear for the cowls. The quarters in the deck house and forecastle are ventilated by 8-inch ventilators. The cargo space is ventilated by sixteen 24-inch ventilators, while one 24-inch ventilator is fitted to the shaft alley and arranged to act as a means of escape therefrom. Two 10-inch ventilators are fitted in the poop for the cargo space and one 15-inch ventilator for the steering gear space.

Propelling Machinery

The propelling machinery consists of a vertical inverted three-cylinder, triple expansion engine with cylinders 24½ inches, 41½ inches and 72 inches diameter by 48 inches stroke, or a geared turbine of equivalent power, supplied with steam at 190 pounds per square inch from two single-ended, four-furnace, oil-fired Scotch boilers, or with steam at 200 pounds per square inch pressure from watertube boilers of equivalent capacity.

Steam from the main engine is exhausted into an independent cylindrical condenser having a cooling surface of about 3,800 square feet. The air pump is of the Edwards type, 26 inches diameter by 21 inches stroke, worked from the low pressure crosshead of the main engine, while the circulating pump is of the centrifugal type driven by a direct acting single cylinder engine 8 inches diameter by 10 inches stroke. The pump has a 14-inch suction and discharge.

Boilers

If Scotch boilers are installed they are to be of the single-ended four-furnace type, 16 feet 6 inches outside diameter by 11 feet 6 inches long, fitted with four 43-inch inside diameter Morison corrugated furnaces. Each furnace is to be fitted with an improved mechanical atomizing system for burning Mexican fuel oil.

The total heating surface of the boilers is about 6,300 square feet, and they are designed to steam in conjunction with a heated forced draft system. Watertube boilers

of an approved size and type supplying steam at 200 pounds pressure may be substituted for the Scotch boilers.

For burning fuel oil, an approved mechanical atomizing system is to be used, complete with the necessary pumps, heaters, drainers, reducing valves, pump governors, burners and piping. Two fuel oil service pumps are piped so that they can draw from the fuel tanks and discharge through the heaters to the oil burners. One transfer pump is also provided for pumping oil from any one of the ship's tanks to any other tank or overboard. A small commercial type vertical donkey boiler, about 34 inches diameter by 6 feet 6 inches high, designed for a working steam pressure of 120 pounds per square inch, is installed for getting up steam and is fitted for coal burning.

Heater coils of 2-inch diameter standard galvanized wrought iron pipe are fitted in the inner bottom tanks under the engine and boiler rooms and 2-inch standard black wrought iron pipe in bunker tanks with 1-inch supply and drain pipes. A 1½-inch galvanized heater coil is fitted around each suction in the double bottom under Nos. 1, 2 and 3 holds.

Boiler Room Auxiliaries

The boiler room auxiliaries include a 60-inch steel plate fan direct connected to a 6-inch by 5-inch vertical engine. This is located in the engine room to supply air to the ducts to the air heater boxes for the forced draft system.

A 20-ton evaporator is installed with vapor connection piped to the auxiliary exhaust main. A feed water heater is also provided.

A feed and filter tank of about 80 cubic feet combined capacity is fitted in the engine room for receiving the main air pump discharge, the engine drains and the drains from the auxiliary condenser and feed water heater.

Engine Room Auxiliaries

An auxiliary condenser of 800 square feet cooling surface is installed in the engine room and connected up to the ballast pump discharge. The following pumps are provided:

Two feed pumps, 4 inches by 21 inches, attached one at each end of the air pump crosshead, arranged so that they can be worked independently.

Two bilge pumps, 5 inches by 21 inches, attached to the main air pump crosshead.

One evaporator feed pump, 1¾ inches diameter by 8 inches stroke, connected to air pump beams.

One fire and donkey pump, 9 inches by 6 inches by 10 inches vertical duplex.

One donkey feed pump, 4½ inches by 2¾ inches by 4 inches, horizontal duplex.

One ballast pump, 10 inches by 12 inches by 12 inches, horizontal duplex.

One fresh water pump, 4½ inches by 2¾ inches by 4 inches, horizontal duplex.

Why Is a Rivet?

What the Young Draftsman Should Know About Rivets and Riveting

TEK was getting out a plan for a cylindrical oil tank for a wooden steam schooner that we were fitting out. At the vault he had been given a plan of a fresh water tank of the same capacity and of about the right size for his job. He noticed that the longitudinal seams were shown double riveted and the circumferential seams single riveted. At first this puzzled him, but he remembered that riveted pipe is made this way because the stress on a longitudinal seam is twice that on a diameter.

$$\left(\frac{D \times L \times P}{2L} = \frac{DP}{2} \text{ and } \frac{\pi D^2}{4} \times \frac{P}{\pi D} = \frac{DP}{4} \text{ or } \frac{DP}{2} = \text{twice } \frac{DP}{4}\right)$$

Tickled that his technical training was bearing him out he confidently went ahead and finished up his new plan.

He was just about done when young Stevens happened along and commented on the neatness of Tek's tracing. The red and blue dimension lines and the red underlined lettering locked nice, he thought. Tek was flattered, and taking young Stevens into his confidence called his attention to the discovery he had made regarding the single and double riveted laps and demonstrated to him why this had to be.

"But, Tek," said Stevens, "this tank is not a pipe like you describe, because there is relatively no pressure on it except at the bottom. Besides, I heard the chief say the other day that all oiltight work had to be double riveted. This tank is to be used for oil, is it not?"

"Yep."

"Well, then, all the seams should be double riveted."

Tek's jaw dropped. He knew that to make double riveted laps would mean wider plates, or if he kept the same stock widths, then the diameter of the tank would have to be increased to keep the same capacity. That meant rubbing out a lot of colored lines, etc. He knew from past sad experience that the red ones would not come out entirely. Maybe it would be better to trace it all over again? When he had it all fixed up, would someone else come along and poke it full of holes? This was happening so regularly lately that he hesitated. He was losing confidence. Perhaps it would be well to get the fellow who would take the final kick at his plan to give some idea of the viewpoint from which he would criticise it.

Mac was coming down the aisle. Tek hailed him and meekly asked if he would take a look at his plan, and if he found any more mistakes he would then fix them all up at one time. Mac gave his plan the once over.

"Leave out the cement wash," he commented. "That is used in fresh water tanks to keep the water sweet. Oil is not sweet, and it would soon disintegrate the cement anyway. Show a flange for a vent. Make it the same size as that for the filling pipe. Change those ⅝-inch rivets to ¾-inch. Three-eighths-inch ends and 5/16-inch sides really require ¾-inch rivets, and it is the opinion of the majority nowadays that nothing less than ¾-inch rivets should be used for oiltight work. I know that the yard likes to use ⅝-inch rivets, and as a 5/16-inch plate is about the dividing line between ⅝-inch and ¾-inch rivets, we generally show ⅝-inch, but not for oiltight work. That

manhole will not do, either. Show in our standard bolted plate manhole."

"Do you think it would be better to trace the whole over again?"

"No. You can change it quicker."

"But it will look like the devil."

"Nobody here in the office cares, and a blue print softens down a lot of awful hard-looking tracings. Go ahead and change it. Forget that it is a disagreeable job and you will be surprised how quickly it will be done. I see that you still have that colored ink masterpiece idea rooted in your head."

"There is one idea I have not got rooted in my head yet and it is one that is bothering me to beat the band."

"What is that?"

"This blamed ship riveting idea. I do not seem to get it right at all. I cannot keep awake at night long enough to read that new book 'Old Man of the Sea' loaned me. He says that is the last thing on riveting."

"Don't take 'Old Man of the Sea's' opinion for anything. He is a nut. Cut out this book business. You have mental indigestion. That is what makes you sleepy. If you wade clear through that stuff to the end you will find that it is necessary to assume a constant or coefficient that is no more rational or easy to guess than the result itself. Learn the result. Memorize it. It is not a hard job, and when you have mastered it you will have something that the yard understands and something that is acceptable to the classification societies. What is the use of pioneering over a rough road and floundering in and out of all the bad places when you can follow the signs and profit by the other fellow's sad experiences?

"When I started in I studied and worried about shearing resistance of rivets and bearing values of plates, etc. I packed pins and designed riveted joints that were never built, and when I got my first actual job for which I was paid real money I was at a loss to decide what size rivet to put through a 3/8-inch plate and a 3-inch angle bar. Most any apprentice in the yard can tell you offhand that this is a 3/4-inch rivet.

Size and Spacing of Rivets

"I had not bothered with this shearing and bearing business for a long time until the other day, when that structural draftsman who was inflicted on us for a week tried to prove to me that four 7/8-inch rivets were enough for a certain stack casing bounding bar. I told him that the bar was only wide enough for a 3/4-inch rivet, and that it had to be calked watertight, so that the rivets had to be spaced at most five diameters. This meant a lot more than four rivets. He said that if the ship ever sank as far as the stack, it would not matter whether the stack was watertight or any other kind of tight. I did not bother to tell him that a lot of calking is done in places exposed to the weather to prevent rusting and streaking of paint.

"As a draftsman, you are concerned mostly with the size and the spacing of rivets. By size I mean the diameter or nominal size of the undriven rivet. Of course, you know that the hole, and therefore the driven rivet, is about one-sixteenth larger than the nominal size. In other words, the hole for a 3/4-inch rivet is 13/16 inch in diameter.

"Now the size is determined by the thickness of the plate or angle flange to be connected. This relation may have come out of shearing and bearing considerations; but be that as it may, our American Bureau, Lloyd's and Government rules clearly define the sizes to be used for different thicknesses of plate. I suppose that you know that the thickness of a steel plate may be expressed in different ways. The most common way is to speak of it as so many sixteenths. Lloyd's refer to it as so many hundredths. The American Bureau and the Navy Department refer to it as so many pounds per square foot, a 40-pound plate being about 1 inch thick. (If steel weighed 480 pounds per cubic foot and the rolls at the mill were absolutely stiff and did not roll the edges of a plate thinner than the middle, then this would be exactly true.) Here is a partial list of the common rivet sizes and plate thicknesses:

Rivet	Plate		
	In.	In.	Lbs.
1/2	1/4	.22	10
5/8	5/16	.34	12 1/2
3/4	1/2	.48	20
7/8	9/16	.66	27 1/2
1			

"The rules of these different authorities are not exactly the same, and when a ship is built the rules of the governing authority must be carefully and consistently followed. When there are two different thicknesses of plate to be connected the thicker plate will determine the rivet size when strength only is considered and the thinner plate will govern the size when watertightness is necessary. The plate edge may be likened to a beam the depth of which is the thickness of the plate and the span of which is the distance between the rivets. The stiffness of this beam makes calking possible. A thin plate under the long span of the larger rivets would not be stiff enough to calk.

"In inaccessible places tap rivets must be used. These are rivets with a countersunk head and threaded like a machine screw. They are screwed into a tapped hole by a small square shank on the head that is afterward sawed or chipped off. Because the thread weakens a rivet of this kind, it is customary to make them 1/8 inch larger in diameter than otherwise. Rivets 1/8 inch larger are used also where several thicknesses are joined on account of possible unfairness of the hole and to draw up the several thicknesses tightly together. Rivets in bar keels, castings, stems and sternposts are made 1/8 inch and 1/4 inch larger for the same reasons.

"A rivet should not be located closer than a diameter outside of the hole from the edge of the plate. Closer than this would seriously weaken the plate. If the edge is to be calked, it will curl up if the rivet is located any further away than this. Planing the edge of bars and chipping actually brings the rivet a little closer to the edge than a diameter outside the hole. For oiltight work some of our tank-testing friends in the yard crowd in a little closer than this even. A diameter outside the hole, taking into account that the hole is 1/16 inch large, makes the plate edge 1 5/8 diameters from the center of the rivet. Lloyd's give 1 1/2 diameters, but it is best for you to remember that for a 5/8-inch rivet this is 1 inch, 1 1/4-inch for 3/4 inch, 1 7/16-inch for 7/8 inch and 1 5/8-inch for 1 inch.

"For this reason and for the purpose of locating the head well in the flange, a certain flange width is associated with certain rivet size: 2 1/2-inch for 5/8-inch, 3-inch for 3/4-inch, 3 1/2-inch for 7/8-inch, etc.

"Remember that this is all what is called good practice. It is not a result of definite analysis, but a sort of style of majority opinion that works. You can depart from these rules without the world coming to an immediate end, but it is easiest to follow them as closely as possible. The yard kicks when there are different size rivets in the same plate. It means changing the punch or rehandling the plate, and for this reason it is best to strain a point and if possible keep the rivets all the one size.

"The distance from the center of one rivet to the center of the next one in the same row is called the spacing. The nature of the work and the location in the ship determines this spacing. Oiltight work requires rivets spaced 3 and 3½ diameters in plate laps and 4 diameters in shapes; watertight work, 4½ and 5 diameters. Spacing is given in diameters because in that way it applies to rivets of different sizes. All rules have tables that give the actual pitch or spacing in inches for the different sizes and diameters. Old Jerry had a negative made of one of these tables and got out some prints which he pasted on pieces of fiber of a good pocket size and distributed them among the fitters. If you want one, maybe he will give you one. Tackle him on his blind side, however, because he is a Tartar.

"In general, don't space rivets closer than 3 diameters nor farther apart than 8 diameters. When strength and not watertightness is required, space them 5 diameters.

"As to the width of seams, laps and straps, the best thing for you to do is to refer to the table of rules of the classification society you are required to follow. No general rule will cover the small differences that exist between the various rules, and although these differences are really unimportant they are definitely stated and, because they form part of the contract, must be followed. I make no effort to remember these distinctions, but resort to the rules when the point comes up. This is best for you also. When the time comes, do it deliberately and there will be no difficulty.

Types of Rivets

"As a draftsman you do not have to bother with the kind or type of rivet to be used. Rivet iron of the various sizes is ordered (as a percentage of the whole steel weight) and rivet machines turn out for stock the kind of rivet that may be required. A man driving rivets knows better than anybody else the length, etc., of rivet he wants. He gets what he wants, too. Watch a rivet gang working and you will soon decide to 'let George do it.'

"But there is one thing that you should know, however, and that is the proper shape of a rivet head and of the countersunk point, so that when you have to make a large scale drawing of some riveting detail, showing clearances, etc., your rivet heads will not look like toadstools or tacks. Roughly, a pan head is about three-quarters of a diameter high, the top is a diameter in diameter and the bottom of the head is about 1½ (1.6) diameters in diameter. For closer dimensions than these go to the rules. The angle of countersink for ¾-inch and ⅞-inch rivets is 45 degrees, 53 degrees for ⅝-inch and 37 degrees for 1-inch rivets, so that a convenient way is to cut or scratch a line bisecting one of the 45-degree angles of your triangle which you can use with another triangle by placing this line over the centerline of the rivet to draw in the sides of the countersink. For the ⅝-inch and 1-inch rivets a little more and a little less helps the appearance.

"With the expansion of the sphere of loft work that is going on in these times, the loft is taking upon itself more and more the work of riveting details. They should. A man who is making templets to full size, if he is competent, is in a better position to puzzle out rivet problems than a draftsman working to a small scale. Stopwaters, liners, quilting, or tack rivets can be handled best in the loft and the yard. That is the way it is done here in this yard, anyway, so you need not bother your head about them. A bulkhead liner or lozenge liner, as it is sometimes called from its peculiar shape, has to be figured. This is a liner that is fitted to an outside shell strake in way of a watertight or oiltight bulkhead. Some kind of a liner has to be fitted here, and usually one is so designed that by its shape helps to make up for the weakness caused by the close spacing of the row of watertight rivets. The idea is to make the strength or area through an inner and outer strake and the liner equal to the area through a row of non-watertight holes through the same strakes. It is just a little puzzle and a matter of cut and try.

"It is too near quitting time now to explain this further, and, besides, I have a car to catch. To-morrow we will take this up again."

Proposed Method for Safe Transportation of Supplies to Europe

Plans by which it is claimed supplies can be safely transported from the United States to Europe have been proposed by John L. Bogert, consulting engineer, New York. To accomplish this result, and thereby overcome the U-boat menace, it is proposed to ship the supplies in fleets of merchant vessels, each fleet consisting of four merchant vessels, convoyed by a specially constructed, unsinkable armed merchant vessel, equipped with aeroplanes for scouting and offensive purposes against hostile submarines. The success of this scheme would depend, of course, upon the amount of protection afforded by the specially designed unsinkable convoy ship.

According to Mr. Bogert's designs this vessel would be about 560 feet long and 80 feet beam, with a deadweight carrying capacity of 15,000 tons. The extreme width is accounted for by the fact that the vessel has practically a double hull, the space between the inner and outer hulls being thoroughly subdivided by longitudinal and transverse bulkheads into a cellular structure designed effectually to resist torpedo attack and thus render the boat unsinkable.

For offensive purposes the convoy ship is armed with rapid fire guns and is equipped with aeroplanes which can be maneuvered from the upper deck. To make this deck available as a landing stage and "take-off" it is extended for the entire length and width of the ship and is entirely unobstructed by any deck erections, funnels, masts, rigging or fittings. It is claimed that constant scouting with aeroplanes from the convoy ship would lead to the detection of the presence of hostile submarines and that the destruction of the submarines could be effected by bombs dropped from the aeroplanes or by gun fire from the convoy ship.

Assuming that the protection afforded by the convoy ship is effective, one such fleet with a deadweight carrying capacity of 50,000 tons could safely transport to Europe in a year 600,000 tons of freight and with ten such fleets the not inconsiderable amount of 6,000,000 tons of freight could be safely carried across the Atlantic.

Wooden Ship Built in the South Proves Successful Blockade Runner.—The three-masted schooner *Glynn*, the first ocean-going commerce carrier built in Georgia since the Civil War, and so far as known the first launched from a Southern shipyard since the revival of wooden shipbuilding in America, and the first Southern built vessel to take a cargo from an American port for Europe since the war began, has arrived safely at her port of destination in Europe. The *Glynn* was built by the Brunswick Shipbuilding Company, Brunswick, Ga. The keel was laid in March, 1916, and the vessel launched January 12, 1917.

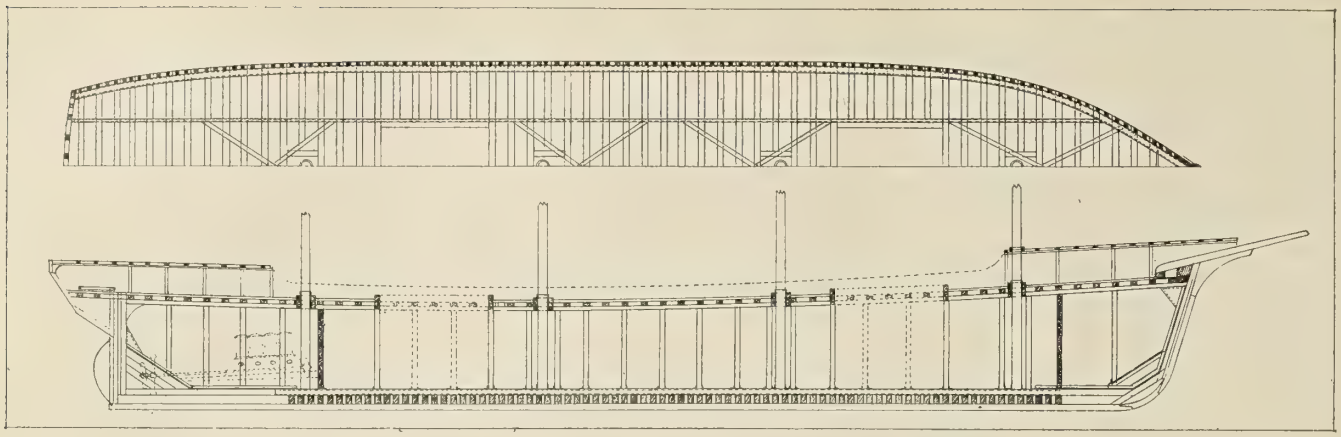


Fig. 1.—Profile of Auxiliary Schooner, Showing Steel Keelson

Special Composite Ship Construction

BY M. F. CARR *

Steel reinforcing in wooden ships is for the purpose of eliminating the heavy timbers in the old type of wood construction, and at the same time to retain the required strength. Past experience has shown that wood and steel form poor construction if great care is not taken in assembling and fastening the members. When connecting iron or steel to wood the bolt holes are from 1/16 inch to ⅛ inch larger than the bolt. The fastening, not being rigid, will work loose after the ship has been in operation a few years, causing the seams to spring and leak, if not developing other serious defects. This is also the main cause of hogging in wooden ships, the greater strains being longitudinal, causing the keel timbers to loosen at the joints and spring.

Figs. 1 and 2 show a special method of reinforcing in a four-masted auxiliary schooner. This method differs from other types in that all steel work is riveted independently of the wood, so as to avoid strains in wood fastening. The keel is constructed of heavy channels running from the forward to the after peak bulkheads, the ends being connected to the stem and stern post with angles. The wooden keel is fastened to the channels with 1-inch bolts. The side, or floor plates, are fastened to the floor timbers with lag bolts and connected to the top and bottom channels with angles.

The top channel or center keelson consists of three 15-inch by ½-inch channels, riveted to the floor plates and also to the flanges. A ⅜-inch plate is riveted to the standing channels, as shown in the drawing. The intercostal channel between the frames, which can be made of any width to suit the frame spacing, is also riveted.

All of the steel work is riveted before the wood is fastened. The reinforcement of the bilge is made up of angles, small plates being connected to the angles at the ends and joints of the futtocks. At the lower and upper turn of the bilge two channels riveted to the angles run longitudinally, forming a girder, as shown in sections *C-C* and *D-D*. The section shown at *A-A* and *B-B* is the alternate frame where the angles are omitted and short channels are used to connect the longitudinal channels.

The brackets or beam knees are made from plates flanged and fastened with 1-inch bolts through the frames and beams. The channels at the deck, shown in detail, are riveted to the brackets. Trusses, as shown in cross section, are placed under the beams and connected to the

* Naval architect, 258 Broadway, New York.

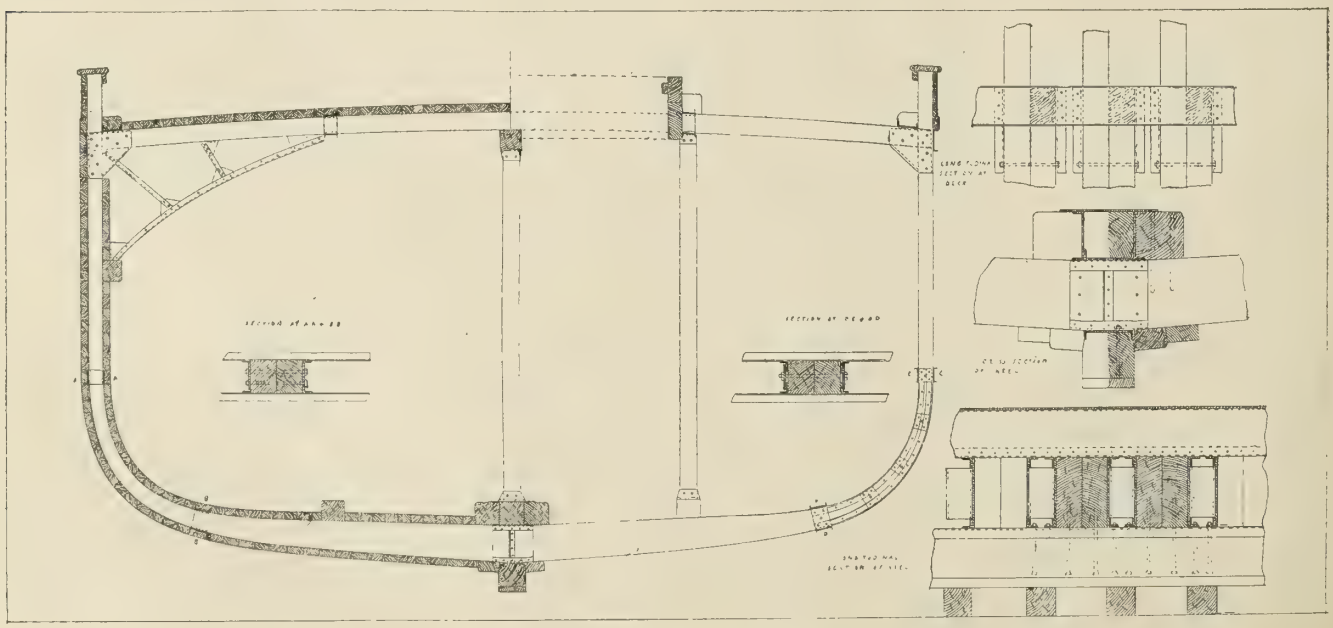


Fig. 2.—Cross-Section of Four-Masted Auxiliary Schooner, Showing Steel Reinforcing

side stringers in order to take the place of hold beams. These can be spaced 12 or 15 feet apart, so as not to interfere with the stowing of cargo. The channels shown in the deck plan run the full length of the ship and are of the same construction as the sections at *A-A* and *B-B*. Tie plates run diagonally and connect to the longitudinal channels.

According to this design, all work can be assembled and riveted without difficulty. Templets for the work can be taken from the mold loft, which will insure accurate work and will also fair the frames and beams. Plates can be used instead of channels for this type of construction, but at the present time structural channels are cheaper and more easily obtained.

For a vessel 250 feet long about 120 tons of steel would be required, and the cost would be about $6,000 (£1,230) or $7,000 (£1,435) more than that for an ordinary wooden ship. The saving in cargo space, however, would be nearly 300 tons, and this advantage would be obtained at a much less cost of upkeep. Ships 300 feet long can be built according to this method with perfect safety. In Fig. 3 is shown a midship section for a ship of 3,600 tons deadweight carrying capacity of the following dimensions:

Length overall	290 feet
Length between perpendiculars	276 feet
Beam over planking	43 feet 6 inches
Depth, molded	25 feet 6 inches
Diseplacement at 22-foot waterline	5,550 tons

The method of construction is similar to that of the auxiliary schooner with the exception of the bilge and sides. There are three strakes of longitudinal channels fitted to the bilge instead of two. Plates are used on the sides and decks in place of channels. The beams, bulkheads and hatches are of steel construction. There are 7/16-inch plates bent or cut to the shape of the frames and fitted between timbers and extended from the lower to the upper turn of the bilge. Every hold beam extends to the brackets. This method of bilge construction has no special advantage over the angle type and is used only as a matter of choice.

The longitudinal channels shown at the bilge run the full length of the ship and connect to the stem and stern posts. They are connected to the frames with flange plates. There are two strakes of plates fitted to the sides at the hold beams, and an upper deck running the full length of the ship connected with the stem and stern posts. There are also two strakes of plates, one on the upper deck at the side, and one on the hold beams at the side known as stringer plates in steel ships. These plates run the full length of the ship and connect to the side plate with angles.

The brackets at the hold beams are beam knees flanged to the side and fastened to the frames with inch bolts.

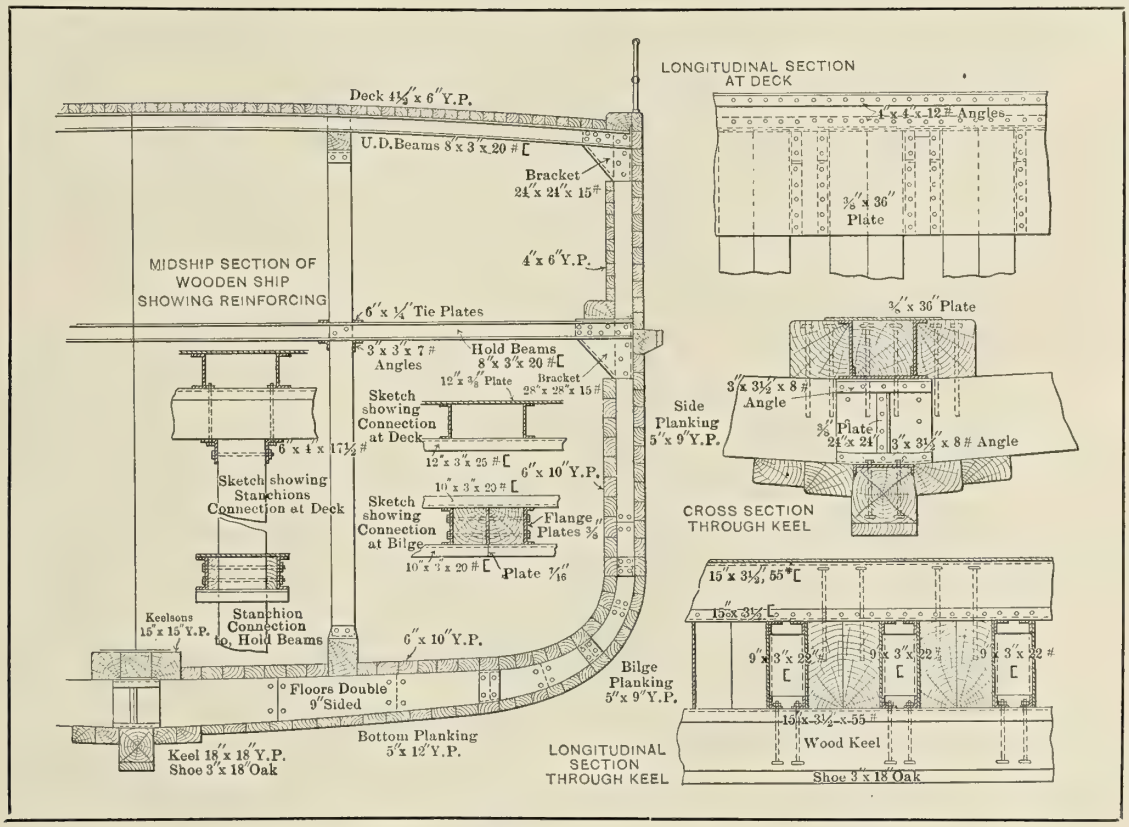


Fig. 3.—Cross-Section of Wooden Steamship with Steel Reinforcing

The upper deck brackets are fastened the same as the hold brackets.

The beams are 8-inch by 3-inch by 20-pound channels. The upper deck beams have a camber of 10 inches, while the hold beams have no camber and are spaced about 10 feet.

The bulkheads are constructed according to requirements of the American Bureau of Shipping and are connected to the center and bilge keelsons with steel brackets riveted with ¾-inch rivets. The hold and deck stringers are continued through bulkheads and connected with angles to bulkheads. The connection of the bulkheads to the hull is by double angles.

Weight of Hull

	Tons
Wood	1,050
Fastenings	90
Steel, including rivets	345
Total	1,485

Shipbuilding Accidents*

Hazards to Which Workmen in a Shipyard Are Subjected—How They May Be Mininized or Eliminated

THE accident history of American shipbuilding closely follows that of European countries, where the industry has a high rank among dangerous occupations. A little study of the conditions under which modern shipbuilding is carried on will show why the accident rate is so high, and a little further study will show that many of the accidents are wholly unnecessary.

Many of the operations in the modern shipyard, where steel is the chief constructural material, are quite different from those that were in vogue in the good old days of the wooden "wind-jammer"; but the changes that have been made have not greatly altered the nature of the hazards to which the men are exposed, and most of the injuries are still due to falls, or to blows from falling objects.

The details of shipbuilding vary from yard to yard, according to the magnitude of the operations, the age of the plant, and the experience and personality of the owner or manager. We believe, however, that the practices and suggestions outlined below are fairly applicable to average yards and conditions.

Blocks for supporting the keel are first placed on ground previously prepared, and supports for a scaffold or staging are then erected around the entire space to be occupied by the ship. From an accident-prevention standpoint the staging is one of the most important things in shipbuilding, because a great deal of plate-erecting, riveting, calking and painting must be done from it. In the commonest method of staging construction two parallel rows of uprights are set in the ground a few feet apart, each upright being provided, from top to bottom, with a series of holes through which bolts may be passed. The bolts support horizontal wooden stringers or cross-pieces, upon which the plank platform of the staging rests. As the work on the ship progresses, the bolts are usually shifted to higher holes and the platforms raised to new levels, though sometimes the old platform is retained and a new one is laid higher up. (In some yards special stagings with metal supports are used, but the safety problem is much the same.)

In many shipyards the men who work on the staging are paid by the piece or area system, and they must raise or lower the staging platforms themselves. As the shifting of a platform is unremunerative work, it is performed as quickly as possible, and not always with safety in mind. In fact, the accident rate from poor staging became so high at one time that a number of shipbuilding companies have placed their staging work in charge of men specially trained to it, nobody else being allowed to move the platform nor to alter the structure in any other essential way. This plan has worked out very well, largely because these men realize that they will be held responsible for all accidents due to faulty staging.

One specially marked feature of permitting or compelling the regular workmen to maintain their own staging is the propensity of such men to use timber and planks that are worn out or badly damaged, or defective in some other way, instead of taking the time and trouble to procure sound and suitable material. Planks and timbers that are seriously warped, split, or otherwise badly damaged should be sawed up or removed from the premises, in order to prevent improper use being made of them. A responsible staging gang, knowing what constitutes a safe working condition and what they have on hand to meet certain requirements, is far less likely to use unsuitable materials.

Men working on a staging often fall from the back of the platform—that is, from the edge that is away from the ship. It is easy to prevent an accident of this kind by erecting a stout railing along the outer row of uprights,† but the railing has been quite generally omitted, mainly because of the time required to install it and remove it. This objection, which is as old as scaffolding itself, is not a sound one, because the gain from using the railing is out of all proportion to the trouble and expense involved in putting it up. The man who thinks it is not worth while takes this view because he is sure he will not have an accident; but it is a matter of common knowledge that accidents of this kind occur every little while, and it is much better to be safe than to be sorry. In fact, being sorry doesn't do anybody any good.

Outside Staging

In some yards plank shelves are put up in the place of guard rails. This is a good plan, because a strong and properly located shelf affords protection to the men, and it can also be used for the storage of tools, rivets, bolts, paint cans, brushes and small material of all kinds. The shelf should be guarded by a board on each edge, however, to prevent objects resting upon it from falling off.

The platform planks of ship stagings should be laid with special care. To avoid all chance of tipping, they should never be allowed to project at their ends more than a foot beyond a firm and solid support, and the men who have charge of the laying of the platforms should make sure that there are no "traps" or points at which the planks can tip between supports, so that the men can fall through the platform to the ground.

The platform planks of ship stagings are seldom secured to their supports except at points where considerable work must be done without disturbing the staging. This is because the men desire to avoid the extra labor involved in shifting the platforms when the planks are fastened down, and also because it is often necessary to move some of the planks nearest the ship, to facilitate the hoisting of plates and other materials into place. The fastening of the planks is far more important in connection with ship scaffolding than it is in connection with the building of an ordinary brick wall, because the jar of the riveting machines and hammers may cause the planks to shift or "creep" until they come into dangerous positions, even though they were correctly placed at the outset. It is well worth while to strap or clamp them to their supports, or to make them secure in some other equally effective way. One method that has been tried with considerable success consists in boring holes through the ends of the planks and through the cross-bars or stringers that support the platform—the cross-bars being made extra wide in this case to allow for the weakening due to the holes. When a plank is laid down, it is placed so that the hole in one end of it comes directly over a hole in the support-

* From *The Travelers Standard.*

† A foot-board should also be used, and wire netting between the two is strongly recommended in addition.

ing stringer, and a bolt is slipped through the two, so that the plank cannot shift its position. No nuts are used, and the holes in the platform planks are countersunk, to receive the heads of the bolts. A plank that is secured in this way can be taken up without any trouble.

Interior Staging

Much of the interior work, such as the erection and plating of bulkheads, is performed by means of ladders, or from scaffolds swung from deck beams or other overhead supports by means of ropes or chains, and many of the hazards incident to labor on the outside staging are also present in connection with this interior work. Moreover, the interior work must often be done from extremely awkward positions, and where there is a temptation to undertake work a little beyond the safe reaching point. The attempt to reach too far is a common cause of the falling of ladders and of workmen losing their balance. Ladders from which work is to be done should invariably be lashed, or otherwise securely fastened, both at the top and at the bottom. Even though considerable delay is involved, stagings and ladders should be adjusted to the convenience of the workman, if accidents from overreaching are to be avoided.

In view of the vast amount of work that must be done from shipyard stagings, strict supervision should be exercised over the construction and maintenance of all structures of this kind. A busy yard can ill afford to dispense with the services of a capable staging supervisor and his gang of workmen. It is certain, for example, that a competent supervisor would not permit a double-decked staging to be used without adequate overhead protection to the men on the lower level; yet scaffolds of this kind, without any protection whatever, are very commonly seen in shipyards.

In building a ship there is a certain point at which the accident rate is likely to reach a "peak," and experience shows that this occurs when the framework of the vessel is being placed. The ship is then a mere skeleton, and the men have to perform arduous work with very insecure footing. During stormy weather they are likely to lose their balance from gusts of wind; or beams or plates that are being swung into position are likely to be suddenly swerved by the wind, at great peril to the men. There does not seem to be any way to provide satisfactory safeguards in connection with this part of the work. Only the most skillful and careful men should be employed at it, and they should be set at other tasks whenever the weather conditions add materially to the hazard.

Another hard problem to deal with is the elimination of cuts and bruises and other minor injuries, which are very numerous in the aggregate. Cuts due to handling steel plates with sharp or ragged edges, and finger bruises and lacerations from hammer blows, or from punching or shearing machines, are specially common. It cannot be said that the employment of none but skilled labor constitutes a remedy, for in the main the work that produces these injuries is already in the hands of skilled workmen. The only solution appears to be to stimulate the men in every way possible to exercise personal caution.

Derricks, gantry cranes and overhead railways are employed to hoist girders, machinery and other heavy parts, and to transport them to various sections of the ship. During certain stages of shipbuilding, specially skillful handling of the crane and derrick loads is necessary if serious accidents are to be avoided. The men on the skeleton of the ship have a precarious footing at best, so that poor judgment, or a misunderstanding of signals, when lowering or swinging a load, may either cause a workman to be thrown down from his position or cause him to miss his footing in his quick endeavor to escape Here, again, is an illustration of the need of providing a competent safety man to actively supervise all operations of a dangerous character.

So far, we have dwelt mainly on accidents due to falls from staging, ladders and other elevated structures. One other source of falls must also be prominently mentioned. It would be hard to name an industry in which there are more opportunities than shipbuilding affords for falling into unprotected openings. In the modern vessel with several decks there are many openings for ventilators, bunker hatches and other permanent uses, in addition to those that are left for temporary building purposes. Unless these various openings are covered over whenever they are not actually in use, workmen and others who may have occasion to go near them are in danger. Stout wooden covers, with the edges on the upper side beveled, are excellent safeguards, and when they must be left off to admit light and air, strong wire-mesh guards may be used instead of solid wooden ones. As workmen are prone to remove covers of this kind and leave them off, it should be the duty of some one specified man to see that a sufficient number of proper covers are provided, and that they are *kept in place.*

The influence of poor illumination on the accident rate in shipbuilding has been very marked in the past, but there is evidence that lighting conditions are being rapidly improved. Formerly, a ship under construction, having no self-contained lighting plant, usually depended on gasoline torches or oil lamps, and this condition still exists in many sailing vessels and in some steamships. Explosions and fires, with resultant burns, were frequent occurrences. In addition, parts of the ship that were not much frequented were left in total darkness, while other parts were not lighted well enough to permit a maximum of efficiency and safety in the work. Of late years, the extension of lines for the transmission of electrical energy, and the installation of power houses at the shipyards themselves, have made available a very flexible source of power and light. It is a simple matter to string wires to any part of the ship and to use the particular size and type of lighting unit best suited for the space to be illuminated. Particular attention should be given to the lighting of the approaches to the ship, where large-sized lighting units, suspended well above the ground, are desirable.

Each year shows a number of serious and fatal accidents to boys of from fifteen to eighteen years of age. While serving their apprenticeships the boys are at first employed as rivet heaters, rivet catchers and markers, and in performing work of this nature they are often stationed at high elevations and in dangerous and exposed parts of the ship. The boy who heats the rivets throws them to another at some distance, who catches them in a keg or bucket and quickly places them in the holes for the riveter to drive. Speed is essential in order that the rivets may be as hot as possible when they reach the holes. It is evident that the ability of the rivet heater to throw the rivet accurately has an important bearing on the safety of the rivet catcher as well as upon that of other employees at work below. If the rivet-heater's aim is poor, the catcher must either reach out at the risk of losing his balance, or else allow the rivet to pass on with the chance of striking someone below. None except mature men should be assigned to this work, and those at work directly beneath the rivet catcher should be protected by hanging a substantial, close-meshed wire netting under the working area and moving this netting as the work progresses.

(To be concluded.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Valve Disk Troubles

Considerable trouble was experienced for several years by the breakage of stems of the metal valve disks of our Blake Knowles feed pumps, as shown in Fig. 2. Many of

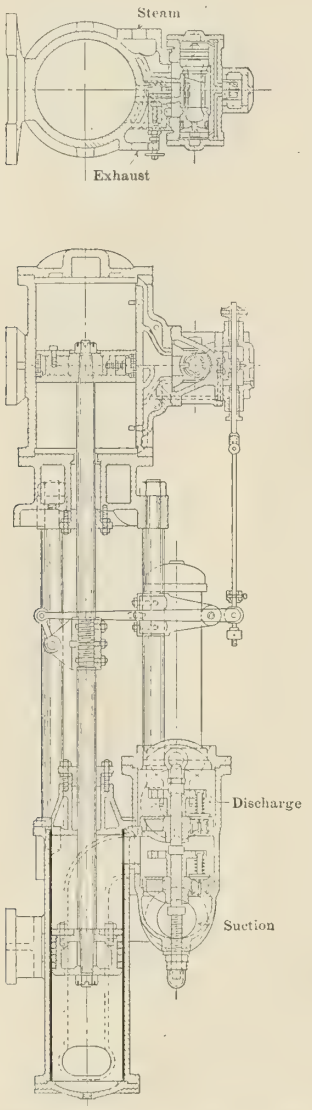


Fig. 1.—Sections of Pump in Which Break Occurred

these broken stems and loose springs caused considerable damage to the valves in the feed line.

Several schemes were tried for repairing the broken valves and to prevent further breakage of good valves, such as inceasing the radius of the fillet on the new valves where the break occurred.

Fig. 3 shows the final scheme adopted to cure this disagreeable trouble. What caused these stems to break is

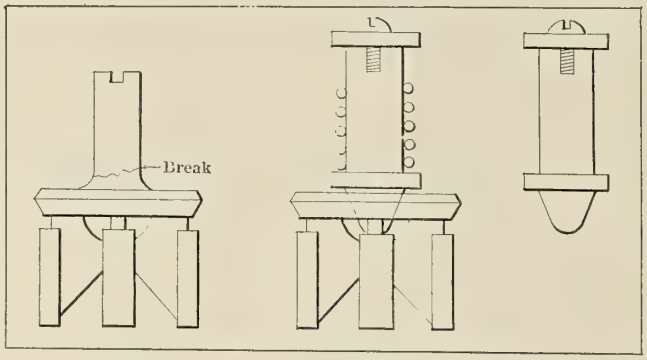


Fig. 2 Fig. 3 Fig. 4

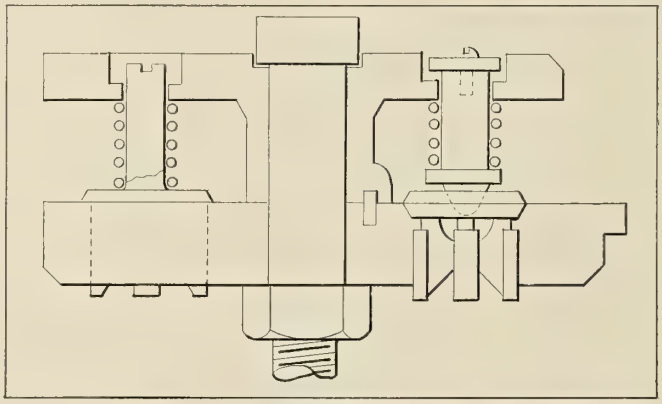


Fig. 5.—Installation of Valves After Repairs

hard to say. The writer has formed the opinion that it is when the pump slams or bucks, such as when steam bound, or when there is trouble in obtaining proper suction.

AUXILIARY.

Make Your Chance

"Gee, if I only had his chance I could have got that place!" So it goes—another fellow blames his failure to lack of chance, and is content to plod along, not attempting to even try to create an opportunity. He is one of many who attribute success to chance.

These kind of fellows are the ones who are always howling about square deal, fair play and favoritism. Are you one of them? If you are, wake up! Stop wishing you had the other fellow's chance. Get up a little steam of your own. The fellow who can help you get a chance is yourself. Stir him up a bit; increase your natural ability by using up some of your brain energy which is now lying dormant. Do not be afraid of making demands on your energy—you can't use it all up. Pretty soon you will feel the call for bigger things; you will then realize that you are fitting yourself.

In place of lamenting about the lack of chance and hard luck, bone up. Get a little more than lukewarm—heat up your enthusiasm to 212 degrees. The result will be self-confidence and reward commensurate with your new ability.

Quit day dreaming and start doing. Look things

squarely in the face—get down to real work and you will wonder why you did not see things this way before.

Some fellows ask: "What more can I do? I've passed the exams and got my ticket. I've worked hard, and still I don't get a show." That may all be true, but your ticket is only a bit of evidence to satisfy the law that you are competent to safely handle the boilers or to take a watch below.

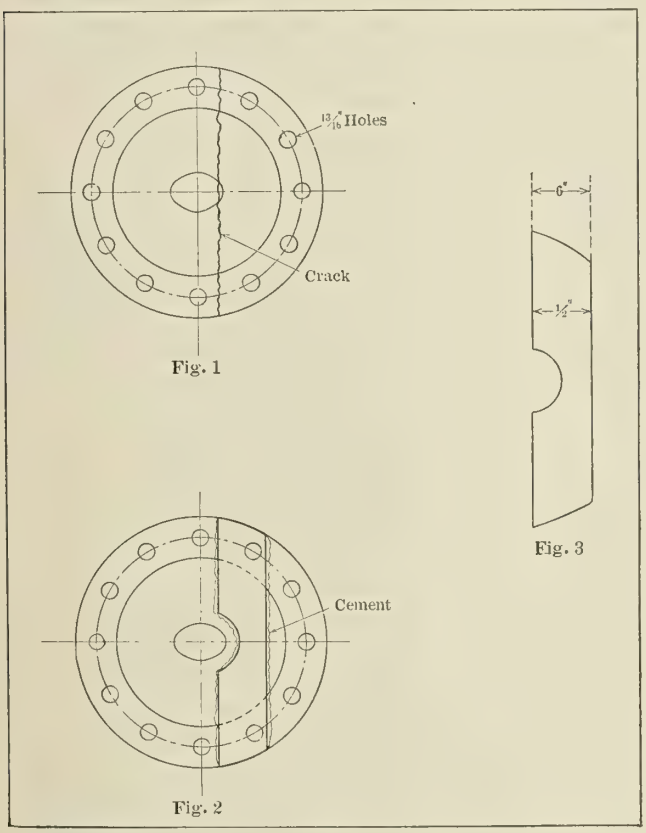
These are days of efficiency—you hear the cry everywhere, efficiency. Entertain no thought of failure, of defeat. You must like engineering or you would not be in the business, therefore develop your talent and use it in proving your worth. Mayhap someone is taking your measure.

CHIEF.

Pump Repair

The cover of our general service donkey pump at the water end developed a crack across the face of the cover, as shown in Fig. 1. As the crack was causing a great loss of water, it was decided to repair it at once.

The repair consisted in securing a piece of plate ½ inch thick by 6 inches in width of a length equal to the diameter of the cover. After checking it out on the center so as to allow it to be fitted hard up against the stuffing box, to insure it being a good fit, two of the ¾-inch studs were drawn because they were too short by the extra thickness of the plate.



Details of Repair to Cracked Cover of Donkey Service Pump

The studs were replaced by longer ones and a good thick coating of cement was made up and liberally spread over the cover, particularly over the cracked portion of the cover. A handful or two of dry cement was then sprinkled over the wet cement, and the plate, Fig. 3, was carefully put on and the nuts screwed down by hand only until the cement had remained some little time to harden. The nuts were finally tightened down with a spanner.

The pump was first started under easy steam until the cement was properly hardened, after which the pump was put to work in regular service. No further trouble was experienced with the cracked cover, although the chief ordered a new cover, which, however, was not put on until after the writer had left the ship.

Sidney, N. S. W. A. L.

Jack Smith, Tramp Engineer

Generally speaking, the tramp was not much on education. He just managed to get his ticket as third assistant after the third time up by being coached and borrowing a few books, the kind supposed to fit a fellow to pass the license examinations. After "copping" his bit of paper from the examiners, he managed to dig up a berth on a tramp sailing for Calcutta.

Of course, there was a lot the tramp didn't know about marine engineering, but he had done nearly everything from stowing bunkers, firing and oiling, and had a pretty good knack for being handy and helping on repairs, etc. So he got along O. K. on the tramp, and began to assume the air of a full-fledged throttle twister.

When he got into an argument or was cornered by any of the ship's force, he would up and tell 'em that "he knew what he knew from practical, everyday experience; he weren't no book-learned engineer, and that none of those kind could slip him anything when it come to using a bearing scraper or coal scoop. Anyhow, there ain't nothing to engineering but to keep the stuff together so's you could keep the screws turning."

One day when Jack relieved the second assistant at four o'clock for the dog watch, he was told to watch the beam air pump (direct connected to the engine), that it was kicking up pretty much and the vacuum had been dropping.

Along about ten or twenty minutes after he took the watch there came a slam-bang noise from the condenser. Jack beat it around the engine four bells ahead and found her mighty hot, and the circulating pump racing pretty fast, with the oiler looking scared to death. It did not take long for the tramp to decide that the engine had to be stopped or the condenser would be put entirely out of commission. Signaling the fireroom and bridge, he stopped the engine and chased the engine room striker after the chief. In the meantime he hunted for the trouble. The first thought he had was that the suction, or intake, was fouled on the ship's side. To clear it by closing the suction valve and blowing it out with live steam was decided upon. After this was done the condenser cooled, but when the engine was started again it soon heated and the circulator had to be run at top speed. The tramp then told the chief that he thought the vane or impeller wheel of the circulating pump was adrift, as the circulating engine seemed to run unbalanced. The chief told him this was impossible, but after hunting everywhere else it was decided that the tramp was right.

To remove the impeller casing and make repairs seemed almost out of question, and then the tramp suggested that they remove one of the lower condenser manhole plates and allow the water to back down through into the bilge, and then pump it overboard with the bilge pumps. The chief thought he was crazy, but they finally decided to try the scheme and make as much speed as possible. Accordingly, the overboard discharge was choked down to three-fourths opening, and the center bottom manhole

plate of the injection end was removed and the floor plates taken up near it. The shaft bilge pump and both engine room and fire room bilge pumps were put on the bilge, the engine started and run at twenty-five turns. This gave 6 knots speed. Some trouble was at first experienced with strainers of the bilge pumps getting choked, and they were required to slow and stop a few times to keep the level down, each time shutting the overboard discharge valve of the condenser until the bilge level was reduced. After a few hours of patient efforts, they were able to make a standard speed of 5 knots, and when they arrived at port they all took their hats off to Jack Smith,

C. H. WILLEY.

"Inspect the Feed Pipe"

I was much interested in reading in the June number of MARINE ENGINEERING the article by C. H. W. entitled "Inspect the Feed Pipe." It recalled to mind an experience of slightly similar nature which I had with B. & W. boiler feeding, minus the exhilarating thrills one must experience when being chased by a submarine and standing a good chance of being overtaken mainly through lack of sufficient water in the boilers.

The good advice given by C. H. W. on the need of inspecting the internal feed pipes is well worth heeding. To facilitate this work, I call attention to the double flanging of the extreme end of the internal feed pipe, referred to further on.

My experience was with a certain vessel equipped with B. & W. boilers. I was troubled a good deal with the water in the gage glasses fluctuating at uncertain intervals, sometimes disappearing altogether for a minute or more. These boilers were filled with purifier drums, one on each boiler mounted above the steam drum. The feed checks were flanged to one end of the purifier, the water emptying just inside through a short nozzle. No internal feed pipe was used. The boilers had been operated in this way for several years. On being satisfied that the fluctuating conditions were mainly due to lack of a properly fitted internal pipe, I had such a pipe installed, and to make provision for readily inspecting and for cleaning the same, I fitted a pair of 6-inch flanges at the extreme end of it, one flange being screwed to the internal pipe, while the other was secured with suitable bolts, thus closing the end, which, being located just within easy access from a manhole plate, could be removed and flushed out when the boiler was being cleaned.

The plan more than came up to expectations. Not only did the fluctuation of the water level end entirely, but the supplying of boiler feed could afterwards be regulated to even and constant work—in fact, the control was made almost automatic.

J. A. MCVAY, Chief Engineer.

BOOK REVIEW

WHARVES AND PIERS: THEIR DESIGN, CONSTRUCTION AND EQUIPMENT. By Carleton Greene, S. B., C. E. Size, 6 by 9 inches. Pages, 248. Illustrations, 154. New York, 1917: McGraw-Hill Book Company, Inc. Price, $3.

REVIEWED BY H. MC L. HARDING *

This book is an aid to the designer in connection with the preparation of plans for the construction of quays and piers. There are only a few books in English available on terminal and harbor engineering and articles on these subjects are so scattered through the reports of societies and technical publications as to make it difficult to find them. The writer has assembled much of this information into one volume of ready reference, and it may be called the first book of its kind published in the United States.

The descriptions of the timber construction of the substructures of piers and quays will well repay careful study. As timber has been used extensively in this country because in the past it afforded a cheap material for construction, there are given many samples of different designs, but, as the author says, timber is liable to destruction or decay, marine animals and fire. Many of the earlier piers were constructed of wood by private owners and permanency was not the essential feature. Municipalities are now constructing, owning and operating marine terminals. Wooden substructures above mean low water are not now considered the best practice, and concrete will be used even more extensively than at present. The relative advantages of different kinds of piling, wood, concrete and combination piles are fully discussed, and from the data given the engineer can form a correct judgment as what to use in the problems met with in his practice. In general it may be said that the conclusions point to the use of concrete for the substructure wherever the financial and other considerations will permit. The section "Concrete vs. Timber" and the table of comparative costs will be found of practical service.

Data are given as to width of piers and the sustaining capacity per square foot. Retaining walls for piers and quays are illustrated fully, and this is the most valuable chapter in the book. The use of rip-rap and the limitations of crib work, with numerous examples, are also included under the heading of retaining walls. Views of cross-sections of many such walls are selected from existing harbor work on rivers, lakes and canals, and references are often made to the work of the New York Barge Canal Engineers. From a study of these, the extensive use of concrete is evident. Timber will be used only for temporary work or where the first cost is the chief consideration. The description of relieving platforms emphasizes the great advantages of this type of construction in respect to saving in construction and in long life.

The discussion on sheet piling construction leaves nothing to be desired. The question which always occurs to terminal engineers after the local conditions are fully understood—"What kind of a pier shall I design?"—can be answered by a careful study of the many designs of piers given by the author.

The chapter on sheds is excellent, although it is to be regretted that it was not extended to embrace more types. Pier and quay fenders, mooring posts, cleats, bits and bollards are well illustrated. That railroad tracks should not be depressed is in accordance with modern practice, but the paragraph on the location of the tracks in relation to the pier and shed cannot be approved as the best.

The chapter on cargo-handling machinery well describes the few existing machines and methods in operation in the United States, but these methods do not give results in economy and speed in comparison to those at European ports. If the United States is to compete for foreign commerce, it must not pay three times as much for freight handling as its competitors, and must not take three times as long to discharge and load vessels.

In the appendix, various data are given of the costs of structures, but in many cases no reference is made to the year of the construction, so that the prices in most cases will have to be used with care.

On the whole, it may be said that the book is satisfactory, especially that part which refers to retaining walls and superstructures.

* Consulting Terminal Engineer, New York.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

The "Willans Line"

Q. (897).—What is the "Willans Line"? I have seen it spoken of in discussions of engine economy tests and have been unable to find any description of it in the text books which I have.

A. (897).—The Willans line is a curve obtained from water rate trials of an engine at different loads. It is a plot of the total steam used per hour (or water rate × horsepower) as ordinates on horsepowers as abscissæ. (See sketch.) In throttle-controlled engines it is, or

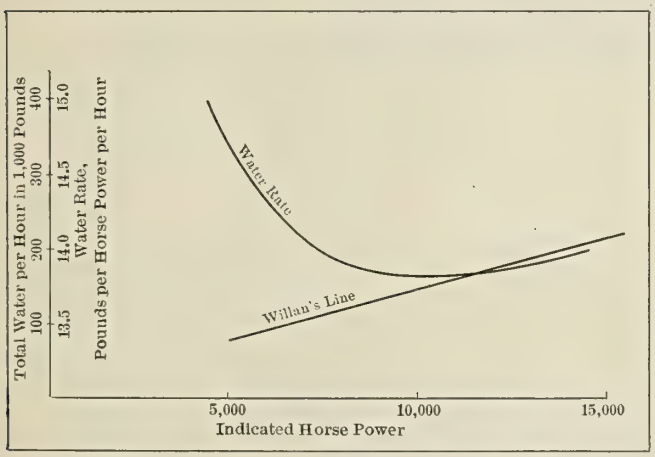


Diagram of Water Rates of Engine at Different Loads

should be, nearly a straight line and interpolation and extrapolation can be more easily made from it. Its departure from a straight line is a variation of the water rate from constancy. The points of tangency of the curve to a straight line drawn to the origin gives the most economical load. Willans law states that at fixed cut-off and varying pressure the steam consumed per hour is represented by an expression of the following form:

Total steam per hour = C. $C \times$ horsepower, where C and C are empirical constants.

Text-Books on Thermodynamics

Q. (899).—Please give me the names of some good text-books on thermodynamics.

A. (899).—Thermodynamics of the Steam Engine. By C. H. Peabody. John Wiley & Sons: New York.

Principles of Thermodynamics. By G. A. Goodenough. Henry Holt & Co.: New York.

Theory of Heat. By Thomas Preston. Macmillan Company: New York.

Technical Thermodynamics. Vols. I and II. By G. Zeuner (translated by J. F. Klein). D. Van Nostrand Company: New York.

"Dry Back" Scotch Boiler

Q. (898).—In a recent article I saw mention of a "dry-back" Scotch boiler. Can you tell me what is meant by this? Is it the same as the ordinary Scotch boiler? If not, can you give me a sketch of it?

A. (898).—In the dry-back Scotch boiler the furnace extends clear through the boiler and the combustion chamber (A) is external to the boiler, being formed by the extension of the shell and the setting at the rear of the boiler. It is rarely found in marine practice, but is common for stationary plants ashore. The figures given above illustrate the two types.

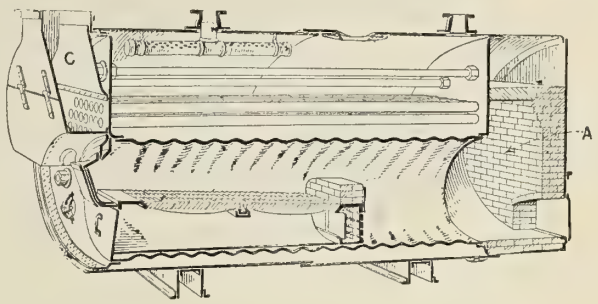


Fig. 1.—Section of Dry Back Scotch Boiler

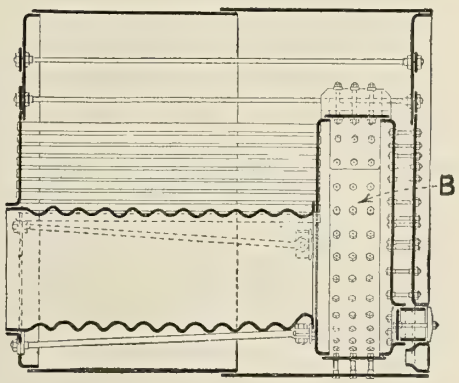


Fig. 2.—Section of Wet Back Scotch Boiler

Steam Turbines and Diesel Engines

Q. (900).—Please describe principles and operation of steam turbines and Diesel engines.

A. (900).—Your question is too broad for answer in this column. Consult "The Steam Turbine," by Robert M. Neilson, Chapter IV (Longmans Green & Co.).

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

REINFORCED CONCRETE SHIPBUILDING

Shortage of Wood Has Led French Shipbuilders to Adopt Reinforced Concrete for Ship Construction

Fig. 1.—Reinforced Concrete Vessel Under Construction in France

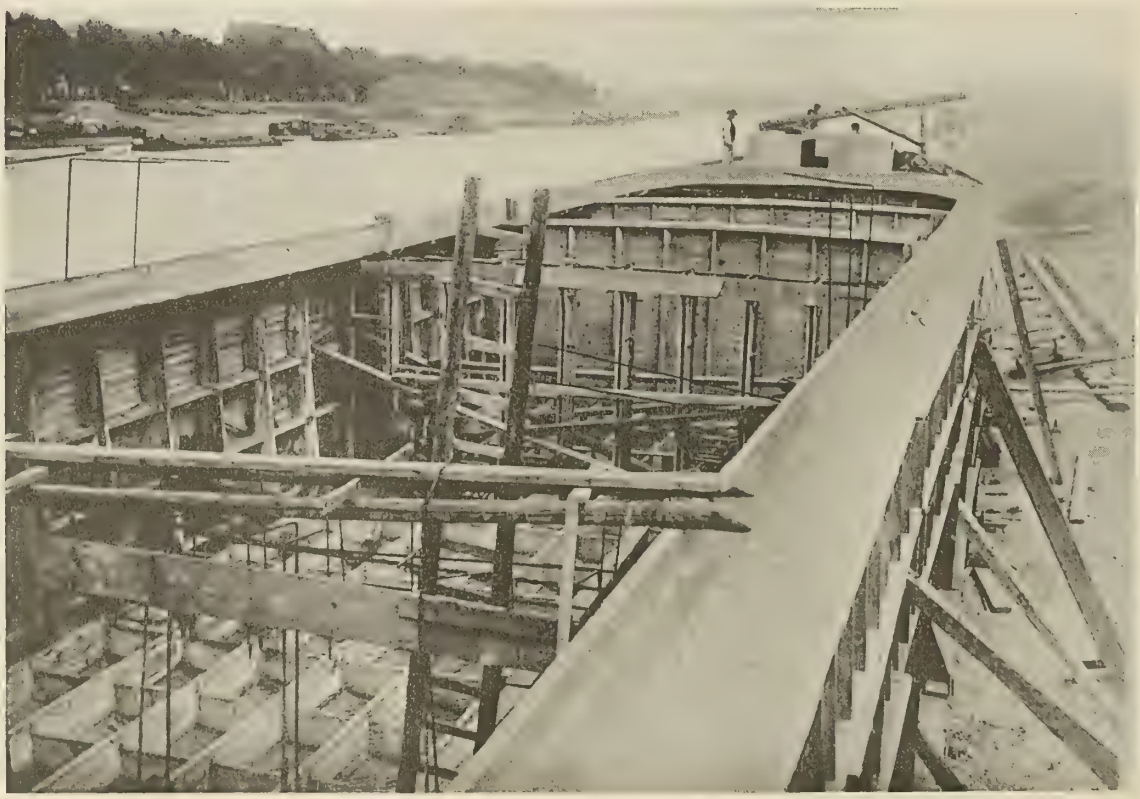


Fig. 2.—Interior of Reinforced Concrete Ship

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

Vol. XXII MARINE ENGINEERING. AUGUST, 1917 No. 8

PROGRAMME TO FEDERALIZE SHIPYARDS

Statement by Gen. Goethals Outlining Method of Requisitioning Ships and Basis of Compensation

The following statement was authorized by Gen. Goethals, general manager of the United States Emergency Fleet Corporation, before his resignation:

It has been decided, after consultation with representatives of the shipyards, that the construction of steel merchant ships in all the shipyards of the United States must be hastened—

(1) By the addition of overtime where necessary,

(2) By proceeding to additional labor shifts as soon as may be, and

(3) By the elemination of non-essential refinements of construction and equipment.

It is necessary, also, that each yard increase its production to the maximum, and after the building berths are cleared of ships now under construction be devoted to producing the particular type of ship to which it is best suited.

WILL REQUISITION ALL STEEL SHIPS

Because of their varied contracts for shipbuilding, the yards cannot carry out this programme without the help of the Government; it has, therefore, been decided that the shipbuilding industry of the Nation shall be federalized. All steel merchant ships now on the building berths will be forthwith requisitioned by the United States, and each yard will proceed to complete such ships under the direction of the general manager of the United States Shipping Board Emergency Fleet Corporation, and will take on new work (other than repair work) only with his consent.

No ships under construction for the Navy Department or for any other Government department, or for the United States Shipping Board Emergency Fleet Corporation, and no ship repair work, will be requisitioned at this time.

FAIR PAYMENT ASSURED

It is the policy of the Government to make fair payments for the work done under this programme, so that investment of private funds in the shipbuilding industry may be secured, and to encourage the training of men to work in that industry.

It is essential to the success of this programme that the shipyards and the men employed in them co-operate with the Government.

The programme contemplates that the yards under their present management will hire and pay labor and continue in charge of ship construction as heretofore.

(*Concluded on page 370.*)

GOETHALS SHIPBUILDING PROGRAMME TO YIELD 5,860,000 TONS OF SHIPPING WITHIN TWO YEARS

Contracts for 525 Steel and Wood Vessels Already Let or Pending—Two Government Yards to Produce 400 Standard Steel Ships

In a letter to the chairman of the Shipping Board on July 13, Major-General George W. Goethals outlined the programme of the Emergency Fleet Corporation for building and commandeering ships in accordance with the powers recently granted by Congress. Although General Goethals' letter indicated that he was ready to start this vast programme at once, opposition from the Shipping Board has delayed the execution of these plans until the details can be thoroughly investigated.

General Goethals' statement was as follows:

SHIPS NOW BUILDING

Contracts for 348 wood ships have been let or agreed upon, with a tonnage capacity of 1,218,000 tons, at a cost completed of approximately $174,000,000.

In addition, I have under negotiation contracts for about 100 wood ships.

Contracts for 77 steel ships have been let, or agreed upon, with a tonnage of 642,800 tons, at a cost of approximately $101,660,356.

UNITED STATES SHIPPING BOARD

EMERGENCY FLEET CORPORATION

Washington

JUNE 29, 1917.

To Whom it May Concern:

As a war measure, the Government has found it necessary to adopt the policy of discouraging, * * * the publication and dissemination of information in regard to merchant marine ship construction. * * *

To conform to this policy, the United State Shipping Board Emergency Fleet Corporation hereafter will not be able to give out for publication, or other use, any information relating to the number, size and character of vessels under contract, the place where they are being built, and by whom, the percentage of completion, date of final completion, etc.

(Signed) GEO. W. GOETHALS,
General Manager.

There are thus provided 425 ships of all sorts, with an aggregate tonnage of 1,860,800, at a cost of approximately $275,000,000, besides 100 more wood ships under negotiation. I shall continue to let all contracts for wood ships (of design approved by the naval architect of the corporation) which I can secure from responsible bidders.

CONSTRUCTION OF STANDARDIZED SHIPS

My main reliance for getting the greatest amount of the most serviceable tonnage in the shortest time will be on the construction of fabricated steel ships of standard pattern. For that purpose I shall use to some extent the existing yards.

On July 16 I shall offer contracts for the building of two plants (to be owned by the Government) for the construction of fabricated steel ships, to produce 400 ships of an aggregate tonnage capacity of 2,500,000 tons within the next 17 to 24 months. For the building of these two yards and the construction of ships in them I shall offer as compensation to the agents who undertake the work a fee of approximately 6 percent of the total cost of the work, with rewards for savings on cost and for speed in delivery. Provision will be made for decreasing the fee to prevent unnecessary cost. The contracts will give the Government the benefit of Government-fixed commodity prices and will provide for cessation of work at any time, so that the appropriation may not be exceeded. Options will be given to the contractors to purchase the plants at arbitrated values on the completion of the work.

The design of the ship is ready, the plans of the yards are ready, the distribution of the work of furnishing the material and of fabrication is arranged.

This part of the programme will take all the $550,000,000 available not absorbed by contracts made or making, as stated at the beginning of this letter. The programme will more than redeem my estimates to the Congressional committee at the time this appropriation was asked for of 3,000,000 tons of new construction within 18 months.

The additional contracts for wood ships which I expect to place, together with the full number of fabricated steel ships which it is planned to build, will

require more money than Congress has authorized. When I know how much will be needed it will be necessary to ask Congress for further sums.

Commandeering of Ships in Yards

On July 16 I shall deliver to shipbuilders a general statement of the programme which I have long been maturing for commandeering ships now under construction for private account (such ships having an aggregate tonnage considerably in excess of 1,500,000 tons).

The essence of this programme is to commandeer all such ships and expedite their construction by adding labor and cutting out refinements. By thus federalizing each yard, giving it Government help and putting it on a speed basis, we shall produce its greatest efficiency. As fast as the berths are cleared each yard will be devoted to the production of a single type of tonnage for which it is best suited. I count upon the complete co-operation of the yards.

This programme is made comprehensive because expedition cannot be obtained in a yard engaged partly on rush work and partly on pre-war time schedules. My investigation has satisfied me that citizens of the United States and of our allies will pay the cost of expediting ships now building for them, and take them off our hands. If this policy is adopted it will conserve our fund.

I agree that it is essential for the Shipping Board to requisition at once the neutral ships which are constructed and ready to sail. I have no data to make an estimate as to how many of these ships there are or how much money will be required for this purchase. I shall, therefore, cut my programme to the extent of $50,000,000. Please notify me at once whether this is enough.

Each day's delay in summer—in commandeering or contracting—means two days' loss of time in throwing the work into the winter months. It is for that reason I am urgent that the programme start on July 16.

Very truly yours,
George W. Goethals,
General Manager.

SHIPBUILDING CONTRACTS

Recent Orders for Merchant and Naval Vessels

The Bath Iron Works, Bath, Me., has received a contract from the Navy Department to build four torpedo boat destroyers.

The South Jersey Yacht Building Company, Atlantic City, N. J., is reported to have received a Government contract to build thirty launches at a cost of about $50,000.

The Howard E. Crook Company, 28 Light street, Baltimore, Md., which is planning to construct a shipbuilding plant, including marine ways and machine shop, is reported to have received a contract to build six wooden hulls for the United States Shipping Board Emergency Fleet Corporation.

The Traylor Engineering & Manufacturing Company, Allentown, Pa., will construct ten wooden vessels at its new shipyards at Cornwells, near Bristol, Pa., now in course of construction.

The Washington Shipbuilding Corporation, Seattle, Wash., is reported to have received a contract from the French Government to build six 2,600-ton auxiliary power wooden ships.

The Humphreys Marine Railway & Lumber Company, Weems, Va., has received a contract from Bellows & Squires, Ocran, Va., to build four oil-burning fishing steamers.

E. James Tull, Pocomoke City, Md., is building four 192-foot barges for the Diamond P. Boat Line, Philadelphia, Pa.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., is reported to have received a contract to build four mine sweepers and two large full-rigged ships.

Bath Iron Works Bought by Syndicate of Maine Financiers

The Bath Iron Works, Bath, Me., which has contracts from the Navy Department for nine torpedo boat destroyers to cost more than $10,000,000, has been sold by the estate of the late John S. Hyde, former president of the company, to a syndicate of Maine financiers, headed by former Governor William T. Cobb, of Rutland, chairman of the Maine Shipbuilding Committee.

Ex-Governor Cobb succeeds Mr. Hyde as president of the corporation, and the board of directors consists of Mr. Cobb, Frederick H. Appleton, of Bangor; Maynard S. Bird, Hugh J. Chisholm and Eleazer W. Clark, of Portland; Henry W. Cushman, of Bangor; Charles H. Gilman, of Portland; Weston Lewis, of Gardiner; H. M. Verrill, of Portland; H. H. McCarty, John McInnes and Charles P. Wetherbee, of Bath.

The shipbuilding plant will be enlarged to co-operate with the Navy Department in meeting the requirements of the present crisis for naval construction.

Fore River Yard Will Employ Eleven Thousand Men

Within the next three months the Fore River shipyard will increase its force of employees to 11,000. Since the declaration of war 1,200 men have been added to the working force of the yard, so that the number employed at the present time is approximately 7,500.

The importance of the rapid growth of the Fore River yard can be realized when it is known that practically one-third of the torpedo boat destroyers and over one-half of all the submarines now being built for the United States Navy are under construction at this yard.

The Moore & Scott Iron Works Becomes the Moore Shipbuilding Company

With the sale of the interests of H. J. Scott and J. J. Scott in the Moore & Scott Iron Works, of West Oakland, Cal., to J. E. and Andrew Moore, the name of the company will be changed to the Moore Shipbuilding Company, and numerous additions and improvements will be made in the company's plant.

The new firm will expend $1,500,000 on improvements, and when the additions have been made the plant will occupy about 44 acres of land. The yard is at present building eight large vessels, and the new management expects to receive contracts for a large number of Government merchant vessels.

Rear-Admiral D. W. Taylor Receives Franklin Medal

At a meeting of the Franklin Institute, Philadelphia, Pa., on May 16, the Franklin Medal was presented to Rear-Admiral David Watson Taylor, U. S. N., chief of the Bureau of Construction and Repair. Upon this occasion Rear-Admiral Taylor delivered an address on the "Science of Naval Architecture."

To Federalize Shipyards

(*Concluded from page 369.*)

For work done in carrying out this programme the yards will be compensated on the following general basis:

Basis of Compensation

(A) For work on ships now under construction the yard will continue to furnish, at its own expense, the labor and all materials (so far as not now on hand) necessary to complete the ships, and will be entitled to hold for its own account all payments heretofore made under the construction contracts, and to receive from the Government the balance of the contract prices on the dates and conditions provided in the contracts (with the following modifications):

1. The prices paid will be minus amount saved by elimination of non-essential refinements and plus additional expense of changes in specifications determined upon by the general manager.

2. In the event of any increase in the scale of wages at the yard after the date of federalization, such increase will be paid by the Government if it is found to be justifiable and is approved by the general manager.

3. The Government will pay the overtime allowance (over yard basis) on the cost of direct labor on any ship (or will adopt some other equitable basis as to the overtime expense).

4. In case the yard adds an extra shift it will receive a suitable allowance to cover the extra cost due to lower efficiency of night work under these conditions.

(B) For construction of new ships the Government will pay—

1. Approved material costs (the Government reserving the right to furnish materials).

2. Direct labor cost.

3. An additional sum to include other costs and a fair profit.

All moneys due the yards, except as herein otherwise provided, will be paid in instalments hereafter fixed.

Direct labor cost will be exactly defined.

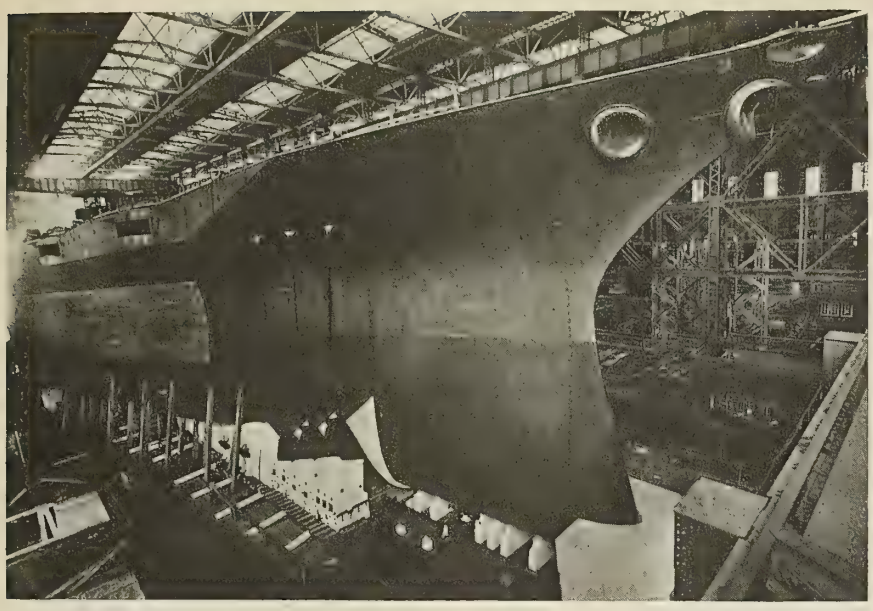
Arrangements for adjusting the payments already made to the yards by ship purchasers will be made by the Government.

Federalization of yards will end within six months after peace (subject to completion of ships under way).

Government May Furnish Funds

If necessity arises, the Government, from time to time, may furnish sums, to be hereafter fixed, for plant and equipment, including the erection of laborers' houses and accommodations (to remain the property of and the income thereof to be received by the Government), on such terms and at such times as may be arranged.

Orders will be issued as soon as may be to each yard separately defining the application of this programme to the particular yard.



Battleship *Idaho* Ready for Launching

Battleship Idaho Launched at Camden

Contrary to the usual custom in times of peace, the latest United States battleship to leave the builders' ways was launched in the presence of only a comparatively few spectators. This was the superdreadnought *Idaho,* building at the New York Shipbuilding Corporation, Camden, N. J., which was launched on June 30, and christened by Miss Henrietta Amelia Simons, the 14-year-old granddaughter of Governor Alexander of Idaho.

The *Idaho* is 624 feet long, 97 feet 4½ inches extreme beam, 30 feet mean draft and 32,000 tons displacement. She is armed with twelve 14-inch guns, twenty-two 5-inch, four 3-pounders, four anti-air craft guns and two torpedo tubes. Her complement consists of 56 officers and 1,141 men.

The *Idaho* is a sister ship of the *Mississippi,* recently launched by the Newport News Shipbuilding & Dry Dock Company, and the *New Mexico,* recently launched by the New York Navy Yard. The keel of the *Idaho* was laid on January 19, 1915, and when launched she was about 70 percent complete.

Dates Announced for 1918 National Motor Boat Show

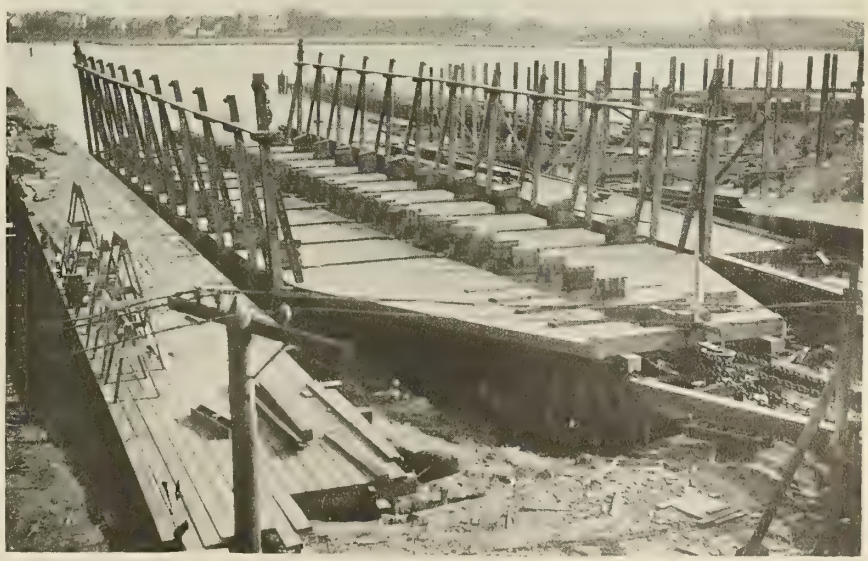
"Big business during the war and bigger business afterward" is the summing up of conditions in the motor boat industry, as expressed by Henry R. Sutphen, chairman of the Exhibition Committee of the National Association of Engine and Boat Manufacturers, in announcing the dates for the 1918 National Motor Boat Show.

The coming show will be the fourteenth annual exhibition under the auspices of this association, and will be held in Grand Central Palace, New York City, opening on Saturday, January 19, and closing on Saturday, January 26. A complete exposition of all the newest types of motor boats, together with latest advanced designs in marine engines and motor boat fittings, will serve to attract many thousands of visitors.

Crandall Marine Railway Installed in New Shipyard at Norfolk, Va.

A new Crandall marine railway of 1,000 tons capacity has recently been completed at the new shipyard of the Southern Transportation Company at Norfolk, Va. The cradle, equipped with patent releasing bilge blocks, is 225 feet long, and is designed especially for barges and towboats.

The railway was designed and built by the Crandall Engineering Company, Boston, Mass., and was put in operation ten weeks after the driving of the first pile. It is electrically operated and has sufficient power to haul a 1,000-ton load in twenty minutes.



New Crandall Railway Dry Dock at Norfolk

SHIPYARD IMPROVEMENTS AND EXTENSIONS

Progress of Work in Enlarging Shipbuilding Plants

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has acquired property at Beach and Palmer streets for extensions to its works.

The American Bridge Company, Trenton, N. J., is reported to be planning for extensions in its local plant to cost about $1,000,000, for the construction of steel barges and vessels of other type. The company's plant at South Trenton has recently been constructing boats of this nature for the Lehigh Valley Railroad, averaging in size about 40 feet wide by 265 feet long.

Seven days after receiving a Government contract for 16 wooden ships the Sloan shipyard at Olympia laid the keels of the first two. This plant already had four 3,200-ton motor ships under construction, and is building ways to lay down two more of the Government ships. The Sloan people recently started enlarging their plant, and will soon be making their auxiliaries in their own machine shop.

The proposed new plant of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., at Spring Gardens, opposite its present plant at Locust Point, will consist of the following buildings: Fabricating shop, 100 by 400 feet; boiler shop, 110 by 340 feet; ship shop, 60 by 340 feet; assembly shop, 80 by 400 feet; layout shop, 60 by 350 feet, and several minor structures, with four new shipbuilding berths. The plant is estimated to cost $3,000,000. Contract for construction of buildings has been awarded to the Belmont Iron Works, Philadelphia.

The Union Iron Works, San Francisco, is planning to spend $2,000,000 for improvements.

NEW SHIPYARDS UNDER CONSTRUCTION

Contracts Placed for Large Shipbuilding and Repair Plants

The Downey Shipbuilding Corporation, 120 Broadway, New York, has commenced active work in the construction of its proposed new shipbuilding plant at Milliken, S. I. The shipyards will be operated in connection with the steel works of Milliken Bros., Inc., at this location. Six shipbuilding berths will be constructed.

The New Jersey Shipbuilding Company, Gloucester City, N. J., recently incorporated, with a capital of $1,000,000, has commenced the construction of its proposed new shipbuilding plant on property adjoining the plant of the Pennsylvania Shipbuilding Company, with which the company is said to be affiliated. The initial works will consist of machine shops, one and two-story; boiler works, joiner and forge shop, plate and angle shop, riveting shop and other structures.

E. W. Heath, of Seattle, is superintending the construction of the plant of the Tacoma Shipyards Company. This company is preparing the ways for six wooden ships and is putting up a 52 by 216-foot two-story machine shop and mold loft and other buildings.

The Patterson-MacDonald Company has let the contract for the building of a machine shop, mold loft, store house, office building and a sawmill on a 25-acre site on the Duamish Waterway at Seattle. This company has a contract to build ten wooden ships, and will build six ways.

Ship Fitters Wanted at Navy Yards

In spite of the fact that the civilian mechanical forces at navy yards and other naval establishments has been increased since April 1 from 25,000 to about 35,000 men, the United States Civil Service Commission in Washington has sent out notice that there is urgent need in the government service of qualified ship fitters at navy yards who will be paid from $4.24 to $4.48 a day.

Practical journeyman boiler makers, who have had experience in laying out work from drawings or blue prints, will be appointed ship fitters, and will be given every opportunity to demonstrate their ability. Applications may be filed at Room 318, Custom House, New York, or with the Civil Service Commission, Washington.

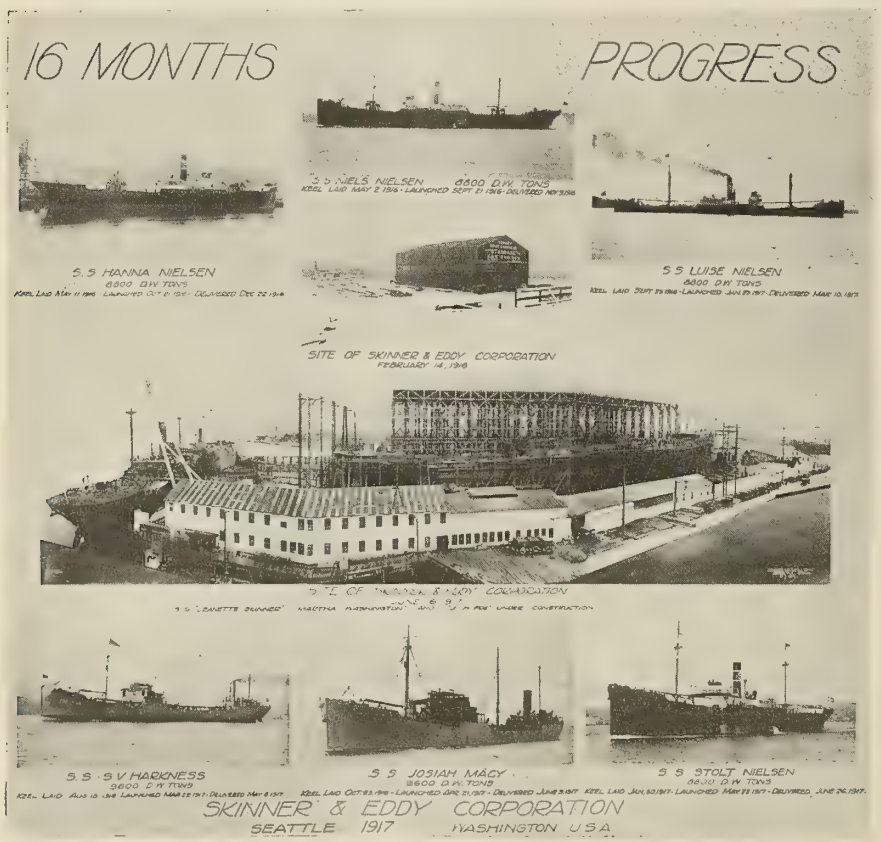
SKINNER & EDDY SHIPYARD RAPIDLY GROWING

Adjoining Property Recently Added to the Plant

Sixteen months' progress at the Skinner & Eddy shipyard, Seattle, Wash., is depicted in the photograph reproduced below. The progress shown was accomplished on three building slips, one of which was added after the plant was well under way.

To make room for two more building slips, which will soon be completed, and on which the ships building under Government contract will be constructed, the company recently acquired the adjacent property occupied by the Hofius Steel & Equipment Company and the Continental Mill. This new addition will increase the acreage of the yard to approximately 25 acres.

To show how the operation of the yard is constantly becoming more efficient under the guidance of Dave Rodgers, the plant manager, who, in a large measure, has been responsible for its success, it may be mentioned that the last ship launched, the *Jeanette Skinner*, remained on the ways just three months and three days, or seventy-eight working days, after the keel was laid. This clips nineteen days from the previous record made in building the steamship *Stolt Nielsen*.



Pictorial Record of 16 Months' Progress at Skinner & Eddy Yard

Dave Rodgers, Works Manager of the Skinner & Eddy Shipbuilding Plant

Werkspoor Diesel Engine to Be Built on the Pacific Coast

The Skandia Pacific Oil Engine Company, San Francisco, Cal., has bought the exclusive manufacturing rights for the Pacific Coast of the Werkspoor Diesel engine. This engine is suitable for vessels up to 7,000 tons capacity, and can be made in units up to 3,000 horsepower.

The Skandia Pacific Oil Engine Company will still continue to manufacture their well-known Skandia semi-Diesel engines in sizes up to 350 horsepower. The Skandia Engineering Company, 101 Grand Trunk Dock, Seattle, are the Northwestern representatives for both the Werkspoor and Skandia engines.

Chicago Marine Repair Shops Combine Under One Management

Announcement was made on June 1 of the combining of the interests and services of A. F. Mitchell & Son, electric boiler welders; G. Brading Boiler Repair Shop, A. E. Clark Electric Repair Shop for motors, generators and electric signaling systems, and E. G. Todt Marine Engine Repair Shop, with the Kraft Shipyard & Dry Dock at Ninety-fourth street and Calumet River in South Chicago. The Kraft Shipyard & Dry Dock is strictly a repair yard, and the enlarged facilities made possible by this union of interests, along with the increased shop equipment recently installed, means an efficient organization for ship repair work on the Great Lakes, exclusive of dry dock work.

SHIPBUILDING COMPANIES INCORPORATED OR PROJECTED

The Kingston Shipbuilding Corporation, Kingston, N. Y., has been incorporated, with a capital of $500,000, to operate a local shipbuilding plant.

The International Navigation Company, Wilmington, Del., is planning for the construction of a new shipbuilding plant at Wilmington, N. C. The proposed works will be equipped to manufacture wooden vessels of 3,000-ton capacity and 5,000 to 10,000-ton steel vessels. It is said that the plant will cost about $5,000,000.

The New Jersey Shipbuilding & Dredging Company, Jersey City, N. J., has been incorporated, with a capital of $500,000, to operate a local plant.

The Cambria Steel Company, Johnstown, Pa., is reported to be planning for the construction of a shipbuilding plant near Savannah, Ga.

The Hollywood Shipbuilding Company has been organized in Oakland, Cal., with a capital stock of $1,500,000. It is understood that the company has contracts from the Shipping Board for the construction of six steel ships.

The Ampco Shipbuilding Company, Milwaukee, Wis., has filed articles of incorporation in Delaware, with capital of $1,000,000, to operate a local plant.

E. L. Bloxom, Newport News, Va., has organized a company to build and operate a local plant for the manufacture of vessels of small type.

The Terry Shipbuilding Corporation, New York City, recently incorporated, is reported to have acquired a site consisting of about 100 acres on the Savannah River, near Savannah, Ga., for a large shipbuilding plant. It is said that the proposed plant will be equipped for the construction of all-steel and wooden vessels, with shipways for twenty ships. Edward F. Terry, president of the Terry & Tench Company, Grand Central Terminal, New York, is president and general manager of the new organization.

The United States Maritime Corporation has been incorporated by Thomas Hampton, 502 Union Savings Bank building, Washington, D. C., and associates, with a capital of $2,500,000, to build and operate a shipbuilding plant near Brunswick, Ga. The company has secured a site of about 100 acres on the Rack River, with 2,000 feet water frontage, and will build a plant with initial capacity of about twelve vessels a year. The works are estimated to cost $200,000.

The Jahncke Shipbuilding Company, recently organized, with a capital of $50,000, has acquired the St. Tammany Ship Yards, near Mandeville, La.

The Pacific Shipbuilding Company has been incorporated at Seattle, and has purchased a 15-acre site on the Duamish Waterway. They will engage in wood ship construction.

(Copyright by International Film Service, N. Y.)

British Transport Torpedoed in the Mediterranean

George A. Gilchrist, Thomaston, Me., has acquired the old O'Brien shipyard, with the intention of building wooden vessels.

The L. M. Danzler Lumber Company, Moss Point, Miss., is planning the construction of a shipbuilding plant on the East Pascagoula River.

The Freeport Shipbuilding Company has been organized at Freeport, Me., with a capital stock of $100,000.

The Lilley-Fletcher Shipbuilding Company has been organized in Los Angeles, Cal., to engage in the wooden shipbuilding business. Their temporary address is care of Henry A. Coit, Marsh-Strong building, Los Angeles. Martin C. Erismann is the naval architect and engineer in charge of the work.

The Beaumont Shipbuilding & Dry Dock Company has been organized at Beaumont, Tex.

The Midland Contracting Company, Midland building, Kansas City, Mo., is planning to build a shipyard at Houston, Tex.

(Copyright by Press Illustrating Service, Inc., N. Y.)

Wooden Shipyard on Pacific Coast

Thirty Million Dollars to Be Expended for Naval Improvements at Norfolk

Within the next two years the Navy Department will expend about $30,000,000 for the improvement of the Norfolk Navy Yard and the establishment of a new naval base on the recently-acquired site of the Jamestown Exposition.

Of this amount, $20,000,000 will be spent on the navy yard, where a machine shop, designed to be the largest in America, costing $4,000,000, covering 5 acres of floor space, will be built, together with a structural shop with tools and equipment to cost $2,000,000, a power plant, costing $1,500,000, a dry dock, costing $5,500,000, and various auxiliary buildings.

One million dollars will be spent for the improvement of the water front at the present navy yard.

Continuous Photo-Printing Machine Widely Used in Shipyards

Every navy yard in the United States, and many of the larger private shipbuilding yards, is using a continuous photo-printing machine manufactured by the C. F. Pease Company, 213 Institute Place, Chicago, Ill. This machine is used in conjunction with an automatic washing and drying machine, manufactured by the same company, both machines being sold under the trade name "Peerless." With these machines a single operator can print, wash and dry 100 linear yards of blue prints per hour, during which time the apparatus consumes 7 units of electrical energy, 60 gallons of water and 50 cubic feet of gas. The prints can be made on separate sheets of sensitized paper, instead of in continuous rolls, if desired.

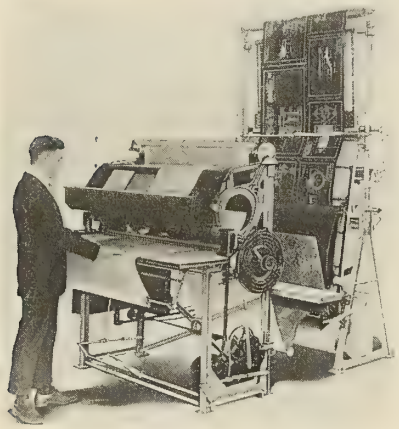


Fig. 1.—Front View

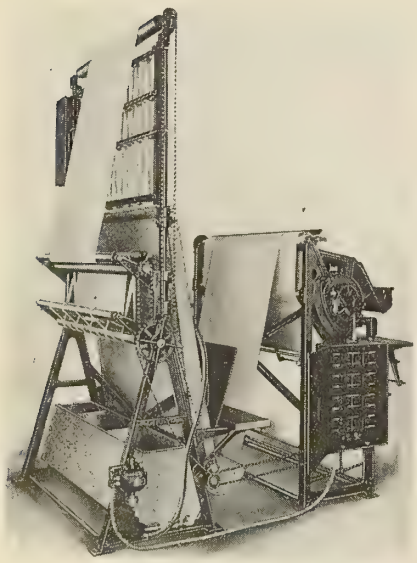


Fig. 2.—Side View

Fig. 1 is a front view of the machines, and Fig. 2 is a side view, showing the course of the paper through the apparatus. The tracings and paper are carried upwards over a cylindrical segment of thick plate glass by means of an endless canvas belt, driven by a small electric motor and kept in tight contact by means of springs. In front of the glass is a bank of five arc lamps of the inclosed type fitted with aluminum reflectors. The number of lamps employed can be varied according to the width of paper used. A small electric fan drives a current of air through the machine in order to carry away the heat from the lamps.

After being printed the tracings are delivered into an iron trough in front of the machine, so that the operator can remove them without changing his position. This trough also serves to catch the exposed sensitive paper if the printing machine is used independently of the washing and drying equipment. Usually, however, the exposed paper passes over a roll at the top of the printing machine and thence to the washing and drying machine, as shown in Fig. 2. This part of the apparatus is driven by chains and sprocket wheels from the motor of the printing machine. The drying apparatus, shown in Fig. 1, consists of a number of Bunsen gas burners, but in the apparatus shown in Fig. 2 the drying is effected by electrically-heated resistance wires, the energy consumed for this purpose being about 8 kilowatts per hour

The floor space occupied by the whole apparatus is about 5 feet 6 inches by 6 feet 6 inches. It is said to be noiseless in action and to work cleanly, so that it can be placed in the most convenient position in the drawing office or tracing room.

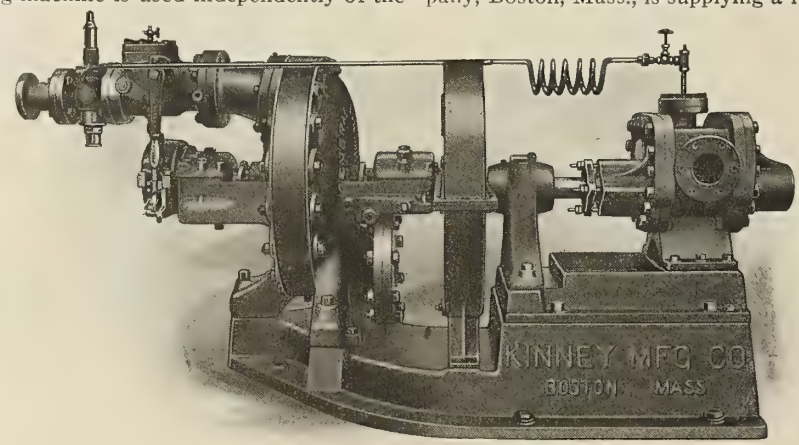
Oxy-Acetylene Torch Cuts Off Rivets or Staybolts Flush with Plate

For cutting off rivet heads and staybolts flush with plates, by the oxy-acetylene process, it is desirable to have a cutting tip so designed as to permit of the gas jet playing parallel with the plates. To meet this need The Prest-O-Lite Company, Inc., Indianapolis, Ind., is manufacturing the special rivet and staybolt cutting attachment illustrated. The copper tip is bent at a convenient angle and is adjustable to any position, facilitating operation in close quarters.

Rivet Cutting Torch

Rotating Plunger Pump Eliminates Trouble with Brick Work of Oil-Fired Boilers

Since the introduction of oil for fuel on board ship trouble has been experienced in the damaging of baffle plates and other brick work in the furnaces. This has been caused, it is claimed, by the uneven flow of oil to the burners, due to the impulses created by the use of plunger pumps. To overcome this trouble, the Kinney Manufacturing Company, Boston, Mass., is supplying a rotating plunger pump, from which the supply of oil is smooth, continuous and uniform, the effect of the impelling force being without pulsation.



Kinney Rotary Plunger Pump

The illustration shows a Kinney turbine-driven fuel oil pump for the battleship *New Mexico*. This same type of pump, with drive, is also to be used on the battleships *Tennessee, California, Washington, West Virginia, Colorado* and *Maryland*, and also on the battle cruisers Nos. 45 to 49. Another use for this type of pump is also found on the above-named ships for supplying lubricating oil. Fuel and lubricating oil and main and trim ballast pumps of this type are also used on submarines, and two cargo pumps of 3,000 gallons capacity per minute each are installed on tank ship No. 16.

Leather Substitute Found for Ship Upholstery

Owing to the immense amount of leather now required by the Government for war purposes in the manufacture of shoes, saddles, harness, puttees and other articles, it has become necessary to find a satisfactory substitute for leather for many manufacturing purposes. For ship upholstery, where leather is not absolutely necessary, the United States standard adopted is Du Pont "Fabrikoid" Craftsman, quality No. 1, manufactured by E. I. Du Pont de Nemours & Co., Wilmington, Del.

This material has several essential qualities that are absolutely necessary in ship upholstery, among them being its mildew, mould and water-proofness. It saves all the waste usually lost in cutting out imperfections and irregular edges of leather, as well as the expert labor which is necessary to do such cutting. It is uniform in thickness, strength and quality, it fits in perfectly with the Govern-

ment's plans for standardization, and is material which has been used on many private boats, yachts and launches. It is appropriate for cushions and other incidental furnishings as well as upholstered parts of the ship.

Large Vertical Plate Bending Rolls Built by Southwark Foundry & Machine Co.

The Southwark Foundry & Machine Company, Philadelphia, Pa., is placing on the market a machine consisting of a vertical set of heavy bending rolls for marine boiler plate. The machine weighs 210,000 pounds, and consists of three vertical rolls, the main or center roll being 30 inches diameter and the two back rolls each 22 inches diameter, supported on a special type of bearings manufactured by the Standard Roller Bearing Company, underneath which, in a pit below the floor line, is the complete driving mechanism.

The screw-down mechanism of the main roll, which is operated by a motor separate from the main driving apparatus, is so arranged that it can be disconnected, allowing the main roll to be thrown out of parallel with the two back rolls for inserting or removing the plates which are to be rolled.

Acorn Dies and Holders Prove Accurate and Adaptable

For a successful threading die not only must a high degree of accuracy and exactness of adjustment be obtained but the tools must of of ample strength, easy to sharpen and readily adaptable to various classes of work. To meet these requirements the Greenfield Tap & Die Corporation, Greenfield, Mass., is manufacturing the Acorn die and holder shown in Figs. 1 and 2.

The lands of the Acorn die are short and wide, so that they will not only be strong but will also have no tendency to twist. The necessary radial movement of the lands is assisted by thinning the section immediately back of the thread,

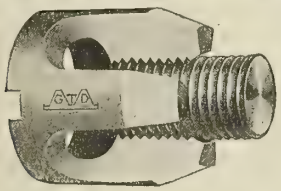


Fig. 1.—Acorn Die

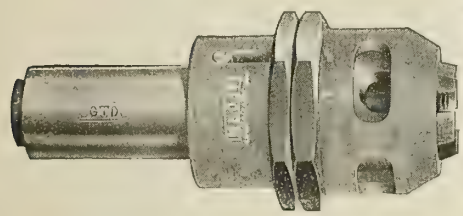
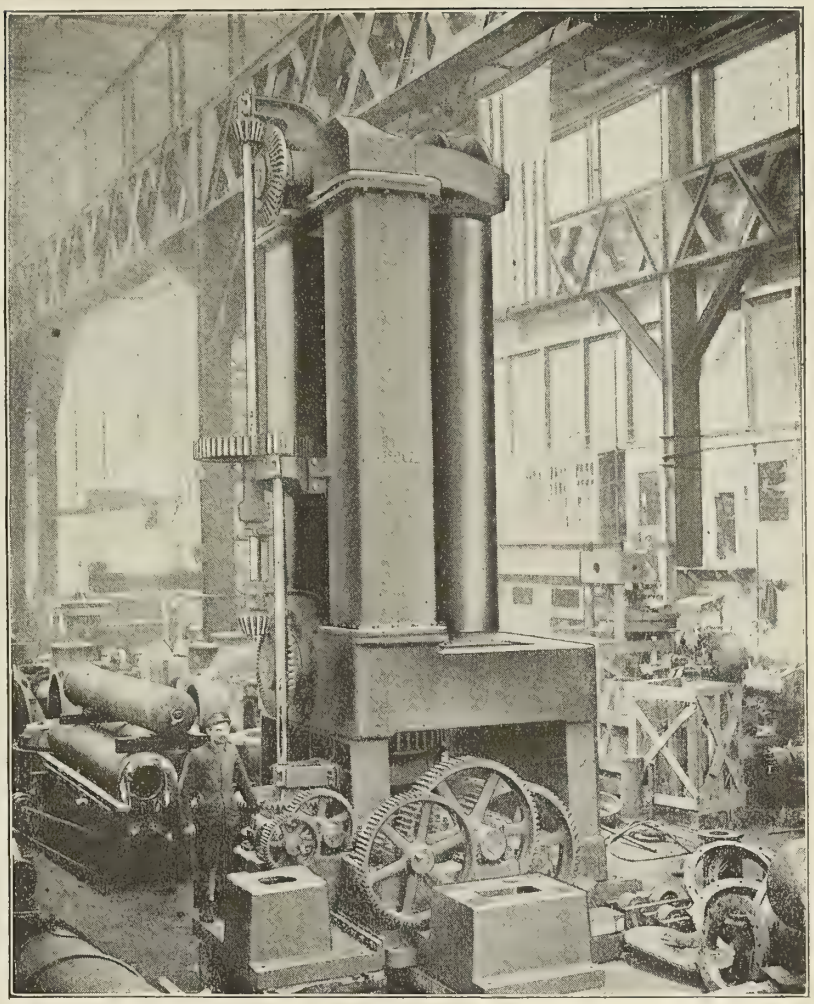


Fig. 2.—Acorn Die Holder

but increasing the width of the prongs at this point makes them uniformly strong and prevents torsional displacement. The base of the die and its seat on the body are ground flat and true to insure preserving absolute alinement when changing dies or when replacing them after sharpening. Notches on the base of the die register with dowels on the body, securing a positive drive.



Vertical Plate Bending Rolls Built by Southwark Foundry & Machine Company

The die is secured to the holder by an adjustable cap, which fits over the die and is threaded on the body below the die seat with a thread of larger diameter. This construction, it is claimed, prevents springing or other accidental misalinement. Slots in the walls of the cap permit the exit of chips that may collect inside the base of the die, and projecting the lands beyond the cap permits the heavier chips cut at this point to fall free of the holder. The nose of each large prong is beveled to conform to a corresponding bevel on the inside of the adjusting cap. The beveled surfaces of both die and cap are ground, assuring perfect contact with the bevels and a high degree of accuracy and adjustment.

National Nautical Training Association Organized

In accordance with a resolution passed at a recent meeting of the National Marine League in New York, a meeting of a committee on organization of a nautical training schoolship system has been held and a permanent organization formed, which will be under the direction of Commander J. W. Miller, to provide for the training of young men as officers for the future American merchant marine.

Plans of the permanent organization provide for giving every assistance possible to the navy at the present time, and for the permanent establishment with State and national co-operation of nautical training schools all over the country.

Three Officers from Government Training Schools Appointed for Merchant Marine Service

The first officers obtained for the new merchant marine by the recruiting service of the United States Shipping Board, whose headquarters are at the Custom House, Boston, Mass., passed examinations before the Steamboat Inspectors in Boston on July 17, and immediately proceeded to New York to take places as third mates on ships now short of officers. The successful candidates were Waite H. Patten, of Malden, Mass.; James M. Earle, Quincy, Mass., and William A. Newell, Boston, Mass. These men are all graduates of the Government school which is being conducted at the Massachusetts Institute of Technology.

Shipbuilding to be Taught at Lehigh University

Lehigh University at South Bethlehem, Pa., will offer next September a course in shipbuilding and ocean transportation in connection with the engineering department of the University. Prof. F. P. McKibben, head of the department of civil engineering, will have charge of the new course.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

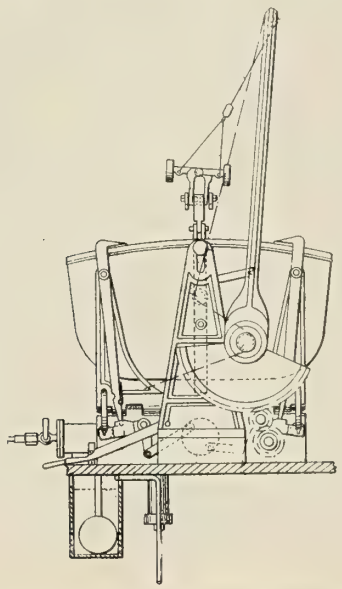
American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,210,374. HULL FOR FLYING BOATS. GLENN H. CURTIS, OF BUFFALO, N. Y.

Claim 1.—In a hull for flying boats, a V-shaped hydroplaning bottom, and a forwardly located longitudinally uniform thickness in lateral extension of the V-sides of said bottom. Twenty-one claims.

1,210,530. DAVIT AND MEANS FOR HOLDING AND RELEASING SHIPS' BOATS, RAFTS, AND THE LIKE. GERARD JOHN PHILLIPS AND LOUIS ANTHONY KELLER, OF SYDNEY, NEW SOUTH WALES, AUSTRALIA.

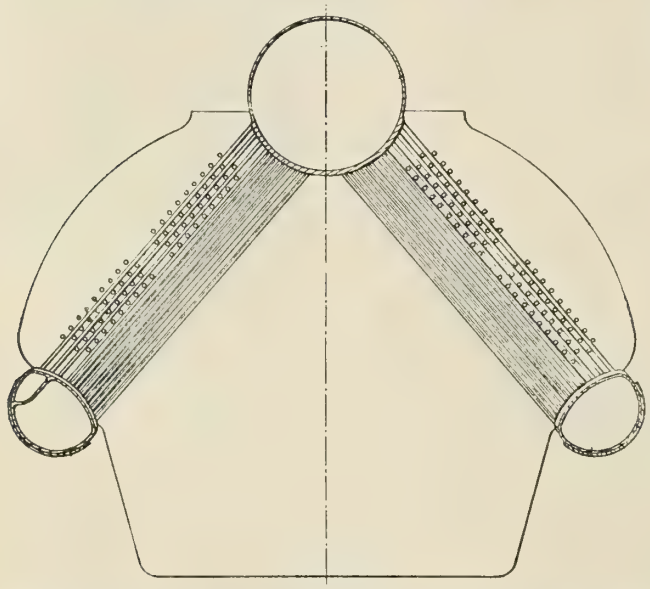
Claim 1.—In means for holding and releasing boats on board ships, the combination of boat holding side frames or chocks adapted to be displaced so as to release the boat davits, means adapted to suspend



the boat from the davits, means for pivotally supporting the boat at the bow and stern independently of said frames or chocks and suspending means when held in the side frames or chocks and means for putting out of action the said supporting means. Nineteen claims.

1,210,976. WATER-TUBE BOILER. CHARLES ALGERNON PARSONS, OF NEWCASTLE-UPON-TYNE, AND STANLEY SMITH COOK, OF WALLSEND, ENGLAND; SAID COOK ASSIGNOR TO SAID PARSONS.

Claim 1.—In a water-tube boiler of A form having a steam drum, and two water drums all arranged triangularly with their axes sub-



stantially horizontal and rows of upwardly convergent straight water-tubes extending between the water drums and the steam drum, and with the fire space between the convergent water-tubes, which are closely spaced apart adjacent the fire space, the combination therewith of a plurality of rows of superheater tubes in single layers intermeshed with single layers of water-tubes out beyond the closely-spaced water-tubes, the superheater tubes of each row being axially parallel with the axes of the drums and spaced apart for the passage of the hot gases laterally between them at different heights as received between the water-tubes at different levels, and located in close proximity to the water-tubes for the transfer of heat to the latter, said superheater tubes being arranged in groups with spaces between the groups for the escape of the hot gases laterally of the tubes, said lateral escape spaces lying toward the outside of and at a point intermediate the length of the bank of closely spaced water-tubes and parallel with the axes of the drums. Four claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

103,754. MEANS FOR MOORINGG SHIPS AND BOATS. W. E. POTTER, OF 11 PAKENHAM ROAD, BIRMINGHAM.

This invention is for the better protection of life and property at sea and provides weighting means for application to anchoring cables of ships and boats lying at anchor. Fig. 1 shows an elevation of the weighting means hanging from the cable by the hook. Fig. 2 shows a similar view of said weighting means hanging from the handle before applied to the cable. The hook is adapted for hanging on the cable. To the shank of the hook is pivoted a lever and handle. The arms of the lever are so shaped with reference to the pivoting point

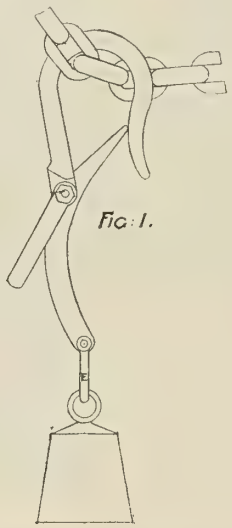


Fig. 1.

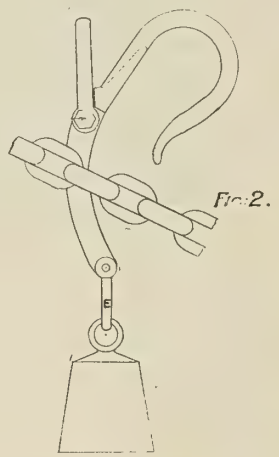
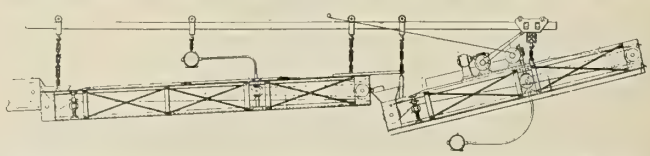


Fig. 2.

that the weight attached to the lower end of the lever by a shackle automatically rocks said lever to two positions, dependent upon whether the weighting means hangs from the hook or from the handle, causing the short arm of the lever to close or open the entrance or mouth to the hook. Fig. 1 shows the entrance closed by the short arm of said lever, for the reason that the weight hangs from the throat of the hook engaging the cable, and Fig. 2 shows said entrance open, for the reason that the weight is hanging from the handle. It will be quite clear from the drawings that so long as the weighting means is carried by the handle the entrance to the hook is open, but immediately said means hangs from the hook the short arm of the lever will close the entrance. In lowering the weighting means into position down the cable towards the anchor, a hand line or rope is attached to the shackle and paid out from the vessel to the desired length, which line or rope is used for drawing up the weighting means again when it is desired to remove it from the cable.

102,831/16. RELATING TO CONVEYORS FOR COALING SHIPS AND OTHER SUCH PURPOSES. G. JONES, OF 25 CHURCH ROAD, MANOR PARK, ESSEX.

The improved appliance consists of a framework in sections, each carrying an endless conveyor and adapted to be detachably secured, say, to the structure supporting the deck head. Each frame also carries one or more electric motors, and one of these which drives a



conveyor is also fitted with or attached to the clutch of a winding gear, capable of shifting the conveyor lengthwise. Another motor which is of the automatically reversible type is capable of swinging the conveyor laterally. At or about the delivery end of the conveyor is provided mechanism adapted to put one or more electric switches into or out of circuit. This mechanism is actuated by pressure of the coal or other material already delivered and is so designed that when a sufficient quantity has been discharged it will press upon the mechanism and close the circuits, thus operating the winding gears and thereby automatically shifting the conveyor until the pressure is released and the switches are opened, the process being repeated as often as the deposited pile of coal or other material reaches the mechanism and operates it. Other conveyors can be employed between the elevator or other means of supply so as to discharge upon one of the first mentioned conveyors. All the conveyors are transportable and may be secured by any convenient means such as stays, clamps, cables or other anchoring devices.

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The Birth of a Permanent American Merchant Marine

WITH government expenditures for merchant shipbuilding, already made or proposed, amounting to nearly two billion dollars, the United States will soon have for seagoing service a brand new merchant marine of nearly eight million tons.

What additions to the present government plans for merchant shipbuilding may be made in the near future can only be surmised. If the war continues, the transportation of our troops and their equipment and supplies to Europe, to say nothing of the transportation of supplies for our Allies, will certainly require more ships. For the transportation and maintenance of each soldier sent overseas, something like four or five tons of shipping is required. If peace comes, the country will have in its possession not only a substantial seagoing merchant marine, for which there will be an urgent need for carrying material and equipment for the restoration of the devastated lands in Europe, but also a thoroughly established shipbuilding industry, the magnitude of which hitherto was undreamed of, involving the investment of vast sums of private capital and thousands of trained men.

The building of merchant ships, however, comprises only a part of the shipbuilding resources of the country. To the merchant fleet must be added the steadily increasing requirements for naval construction which have already absorbed a large percentage of existing shipbuilding facilities and transformed government navy yards into important shipbuilding establishments. To carry out the Navy Department's recent proposal for the construction of a large destroyer fleet, new shipyards must be built and extensive additions made to existing plants. If the war continues, the demands for naval construction will steadily increase. On the other hand, in the event of peace, a large part of the country's shipbuilding facilities now engaged in naval construction will undoubtedly soon become available for merchant shipbuilding, for the urgent need for huge naval armaments will cease to exist, even if some plan for gradual disarmament is not adopted by the nations of the world. With a return to normal conditions, a large part of the ordinary naval programme can, and probably will, be taken care of in the government plants which have been built up in the present crisis. This will mean, then, a large increase in the capacity of American shipyards available for merchant shipbuilding.

Whatever the immediate future may bring forth, therefore, as regards requirements for merchant or naval construction, the fact remains that the United States will have at its disposal resources for shipbuilding sufficient to place it in the front rank as a maritime nation. In addition to the shipbuilding resources, however, which involve enormous sums of invested capital, fully equipped shipbuilding plants, thousands of trained shipbuilders and correspondingly enlarged activities in industries allied to shipbuilding, there is still another factor which will tend to make the American merchant marine permanent.

Since the government started on its huge programme of merchant shipbuilding, steps have been taken to secure men to man these ships. In the face of an emergency, such as now confronts this country, the response from the ranks of seafaring men has been spontaneous. Induced by the opportunity of securing in the training schools established by the Shipping Board free training for positions as officers in the new merchant marine, hundreds of men who have hitherto had experience at sea are entering the government merchant marine service. Some forty thousand men in the United States hold licenses as either navigating or engineering officers in the merchant marine, many of whom have given up the sea and become established in various lines of business on shore. To these men the Service Bureau of the shipping Board is directing an appeal, urging their assistance by returning to their former work on board ship. Under the exceptional conditions now existing, many will undoubtedly take advantage of this opportunity, and by the time the new merchant fleet is finally in commission, the United States will have actively engaged on the high seas a force of experienced seamen, navigators and marine engineers more nearly commensurate with its importance as a maritime nation.

By providing these three prime requisites for a seagoing merchant marine—ships, shipbuilding facilities, and trained men to man the ships—the present emergency marks the birth of a permanent American merchant marine. All that has been accomplished in this time of danger cannot be overthrown in a moment. The foundation has been laid for a permanent place on the high seas for the American flag. It is now up to the American people, through their government in Washington, to maintain this place in friendly competition with the nations of the world.

Protection of Merchant Vessels in the War Zone

IN order to minimize the hazard to vessels trading to or from ports in Europe and on the Mediterranean coast of Africa, the government has established rules relative to the arming and visibility of all American vessels sailing to the war zone on and after October 1.

According to these rules, all vessels must be armed in accordance with the recommendation of the Navy Department, or if the Navy Department is unable to furnish such armament, the shipowners must furnish to the Bureau of War Risk Insurance satisfactory evidence that such armament has been applied for and cannot at the time be supplied. The Bureau will charge an additional

rate of one percent on each voyage of vessels failing to comply with this requirement.

The regulations affecting visibility provide that each vessel shall be painted in accordance with one of the systems that are recommended by the chairman of the Naval Consulting Board and the Ship Protection Committee of the Emergency Fleet Corporation, as approved by the Bureau of War Risk Insurance. Information relative to the various methods of painting and how the painting can be arranged for, will be furnished upon application by the Bureau of War Risk Insurance, Treasury Department, Washington, D. C. Shipowners are free to select any one of the approved methods for their own use, and if they have a better method to offer it must be first submitted to and receive the approval of the chairman of the Naval Consulting Board, 11 Broadway, New York. Certificates from the party performing the work must be furnished to the Collector of Customs at the loading port, upon completion of the work.

Another rule affecting the visibility of a vessel provides that each steamer, at the time of sailing from the United States, must carry a sufficient supply of approved smokeless fuel to carry the vessel for not less than two daylight periods. This coal must be used during the daylight run while within the submarine zone. If the vessel is equipped with an improved system, whereby it can be operated without the emission of visible smoke from the stacks, it will not be required to comply with the above rule. All vessels operating through the submarine zone must also carry on deck one dozen approved smoke boxes, which will evolve smoke when thrown overboard.

Vessels must obtain from the Collector of Customs a certificate that all requirements affecting its visibility have been complied with. In the event of failure to obtain such a certificate, the Bureau will charge an additional premium of one-half percent for each voyage. The Bureau reserves the right to decline to insure vessels whose owners have not, in the opinion of the Bureau, made a satisfactory effort to comply with these requirements.

The above rules are in accordance with recommendations made by the Ship Protection Committee of the Emergency Fleet Corporation. Other recommendations were made at the same time, but have not yet been tested out sufficiently to warrant their being adopted. One of the most important of these is the recommendation made by William T. Donnelly, a member of the committee, providing that ships shall be equipped with buoyant means, so that the ship will be practically unsinkable, however seriously the hull may be damaged by torpedo or mine attack. One of the German ships taken over by the government at a Southern port is now being fitted out in accordance with this recommendation, and tests will soon be made to determine the desirability of equipping all vessels in such a manner. The method of carrying this out consists in fitting between the frames, along the sides of the vessel and against the bulkheads, watertight boxes or containers, the total buoyancy of which will be sufficient to keep the vessel afloat with the holds flooded.

Twin Screw Versus Single Screw Steamers for the Emergency Fleet

IN the Hough type of wooden steamship, described elsewhere in this issue, two distinct features are incorporated which have been patented by the designer. They are, first, the use of a central longitudinal bulkhead, extending throughout the length of the ship, in conjunction with twin hatches, and second, the peculiar construction of the bottom. By extending the centerline longitudinal bulkhead through the machinery space, a twin screw arrangement of the machinery becomes necessary. The adoption of the twin screw arrangement, however, is not solely on account of the longitudinal division of the engine room, but for other reasons which will become apparent after a little consideration.

In the first place, by using twin screws, the engines are much smaller and hence the parts of the engines, being comparatively small in comparison with similar parts of engines for a single screw ship of the same power, can be manufactured in the smaller machine shops throughout the country and a larger and more rapid production of the machinery can be assured. This is not the only advantage of the twin screw arrangement, however, for in the case of partial or total disablement of one engine the vessel can continue on her voyage without assistance.

In the case of the single screw vessel built of wood, if a propeller blade is lost, the vessel is at a disadvantage. Owing to the fact that the propeller with a blade missing is out of balance, the stern bearing in a wooden ship will soon work loose and destroy the watertight sleeve and then flooding may result. To avoid this it is necessary either to run the engine dead slow or to stop. Numerous instances are on record on the Pacific coast of single screw wooden steamships which, after losing a propeller blade and limping into port, have been ordered towed to the nearest port having a dry dock, in order to avoid running the main engines.

Another advantage of the twin screw arrangement is the fact that the vessel can be handled more smartly in maneuvering than a vessel with a single screw. As the speed of the vessels built for the emergency fleet does not exceed that of the submarine, a quick change of course or a zigzag course with quick turns may be of inestimable value while the vessel is in the submarine zone.

Other features of the Hough design will undoubtedly prove of value in the present emergency, but it should be understood that the vessel is not an emergency ship in the sense that it is a hastily built ship good only for a few voyages at sea. The design is thoroughly substantial and seaworthy and was evolved before the present need of an emergency fleet developed. It has been successfully used in the construction of several seagoing steamships on the Pacific coast, entirely apart from the government emergency fleet.

Encouragement for Inland Water Transportation Advocates

THOSE who have in the past been inclined to the view that railroads would, by all means in their power, discourage the use of water facilities by making low competitive rates and through refusal to participate in joint rates and through billing arrangements, declining to build tracks, docks, etc., will be reassured by the attitude of the Chicago, Burlington & Quincy Railroad, as expressed in a recent letter from C. G. Burnham, vice-president of the road, to the Secretary of Commerce. Mr. Burnham states emphatically that it is the earnest desire of the management of the Chicago, Burlington & Quincy Railroad that every opportunity be taken to assist in the development of the practical use of inland waterways. If other railroads, which are in a position to cooperate with steamboat lines, would join this road in their efforts to promote the development of inland waterway transportation, practical results would soon be forthcoming, which, with the present burden placed on traffic, would without question be of great benefit to the country.

LETTERS TO THE EDITOR

Statement Regarding Lord Pirrie's Connection with Motorship Industry Corrected

In your May issue, I find an article written by Mr. T. O. Lisle about "Lloyd George's Speech and Its Relation to Motorship Development." This article, of course, has been read with great interest by all the Burmeister & Wain people, and I only take the liberty to send you these lines in order to correct a few remarks which do not quite agree with the real facts.

At the bottom of page 205 it is mentioned:

"One of the great shipping interests controlled by him (Lord Pirrie) has sold all its steamers and replaced them with Diesel motorships."

We suppose this to be an error, as it is the East Asiatic Company of Copenhagen, which is not controlled by Lord Pirrie, which has sold all its steamers and is now exclusively using Diesel motorships.

Further it is said:

"Furthermore, it is through Lord Pirrie interests that a small European steamship building yard has become one of the most important mercantile motor shipyards in the world. This yard now has its capacity booked for six years ahead entirely with Diesel motorships. No steamship yard in the world is in such a fortunate position."

The concern in question is A. S. Burmeister & Wain's Maskin- og Skibsbyggeri (Burmeister & Wain's Engine & Shipbuilding Company), Copenhagen, Denmark, and only some time after Burmeister & Wain had started motorship building was Lord Pirrie's name connected with this branch of the industry, as he became interested in an activity in Glasgow, viz., The Burmeister & Wain (Diesel System) Oil Engine Company, Ltd. The person who, by ordering Diesel motorships, has caused the rise of our firm to the brilliant position it now possesses, with regard to the Diesel motorship building, is the managing director of the East Asiatic Company of our city, Counsellor of State Mr. Andersen.

For the sake of accuracy, we would point out that our yard has its capacity fully booked for *eight years ahead* (not for six years) with Diesel motorships. Finally, we may add that the exclusive rights for building Burmeister & Wain marine Diesel engines in America have recently been taken over by The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and we hope that within a short time this firm will have the same success with Diesel engined vessels as we have had.

Ivar Knudsen,
Chief Engineer, Burmeister & Wain's Engine & Shipbuilding Company.
Copenhagen, Denmark.

Future of the American Merchant Marine

Mr. N. L. Snow's communication, published in the August issue of Marine Engineering, wherein he pointed out the probable future need for a subsidy, if our vessels are to compete with those operated by other nations when shipping conditions return to normal, was interesting and expressed the consensus of opinion among shipping authorities.

In taking issue with the optimism relative to future shipbuilding evinced by me in an earlier number he has, I am inclined to believe, misunderstood the thought. His statement that "the capitalists who are putting their money into shipyards and export companies might show some concerted opinion, indicating that they expect the Government and the people of the United States to pass a subsidy act which will insure the investments and provide the country with a merchant marine," is synonymous with my former statement that "We cannot build up such a tremendous structure for immediate profit and overthrow it at will."

With respect to the subsidy there is room for considerable diversity of opinion. Certain it is that our freight vessels will be much more numerous and the crews at hand to man them when normal trade is resumed. This, however, will not be directly subsequent to cessation of hostilities, nor for possibly two or three years following that much to be desired event.

The situation in Europe will simulate that immediately after our Civil War, when rehabilitation played possibly as large a part as steel ships in discouraging our merchant service. There is obvious need for merchant ships under our flag, and they will no doubt be demanded by our people, for the shipping question never before gripped the entire populace as it does to-day.

To attempt planning an equitable subsidy under present conditions would be folly, for there is no means of realizing the nature it should take nor the degree to which it should apply. Subsidy under existing conditions is unnecessary. That it will be an adjunct in the future is highly probable, but what man can devise a plan which will prove most feasible in those future times? Let us look to the subsidy when needed, but not until then.

The encouragement afforded by the Shipping Board, and heretofore rather questionable, but which will take more concrete form very shortly, is subsidy in a sense. That the Government has appointed that board is sufficient to vouch for public interest in shipping. That the blunders and politics attending its inauguration will not endure has already begun to be evinced.

We can build and operate ships at a profit, just as we have extended our other industries to the far corners of the earth. It is a question of capital, sustained public interests and efficient administration which will decide our future shipping status. Arthur F. Johnson.

Washington, D. C.

A Clipper Ship of 1853

In view of the present revival in wooden shipbuilding in the United States, the following particulars of an old-timer, seen by Sir Joseph Whitworth on the stocks in 1853, may be of interest. The particulars are taken from the collected papers of this famous engineer, and are contained in his report on the New York Industrial Exhibition.

"A Four-masted Clipper Ship. A large clipper ship of 4,000 tons was being built at Boston; the length of the keel was 287 feet, length on deck 320 feet, extreme breadth of beam 52 feet, and depth of hold 30 feet. Her keel is of rock maple in two thicknesses, the frame is of seasoned white oak, doweled, and bolted together through the doweling with 1¼-inch iron. The frame inside is diagonally cross-braced with iron, the braces being 4 inches wide, and ¾-inch thick, bolted through every timber; these braces extend from the floor heads to the top timbers, and form a perfect network of iron over all her frames, fore and aft.

"She has five depths of midship keelsons, each 16 inches square, bolted vertically and horizontally. There are four tiers of bilge keelsons on each side 15 inches square.

(*Concluded on page* 408.)

Hough Type Wooden Steamship

Designed by Edward S. Hough, Consulting Engineer, San Francisco, Cal., for the United States Shipping Board Emergency Fleet Corporation

SEVERAL of the wooden steamships which are to be built for the emergency fleet of the United States Shipping Board will be constructed according to designs developed by Edward S. Hough, naval architect and consulting engineer, San Francisco, Cal. This type of vessel has been designed with the special object of securing rapid construction and minimum cost, and for this reason it involves a number of radical departures from ordinary wooden ship construction.

The vessel is of the 'tween deck type, schooner rigged, with two pole masts fitted with cargo booms, and is of the following dimensions:

Length over all	286 feet
Length between perpendiculars	276 feet
Beam, molded	45 feet
Beam over planking	46 feet
Depth, molded to upper deck	28 feet
Dead rise	3 feet
Deadweight capacity	3,500 tons
Total horsepower	1,400
Sea speed, loaded	10½ knots

As can be seen from the general plans, the Hough type of vessel is thoroughly adapted for emergency construction in that ordinary ship curves have been eliminated as

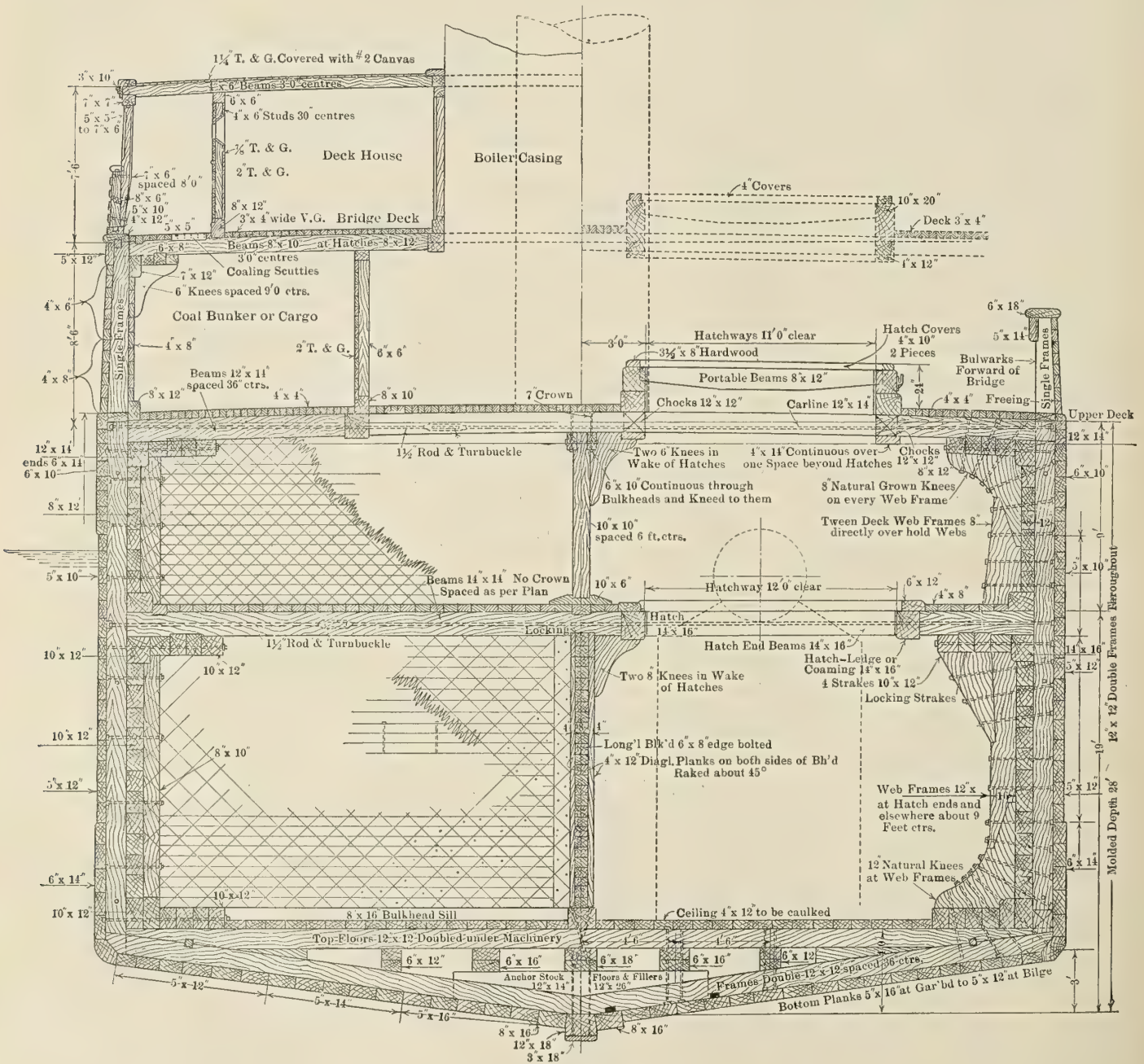


Fig. 1.—Midship Section

HOUGH TYPE WOODEN STEAMSHIP

Designed by Edward S. Hough, Consulting Engineer, San Francisco, Cal.

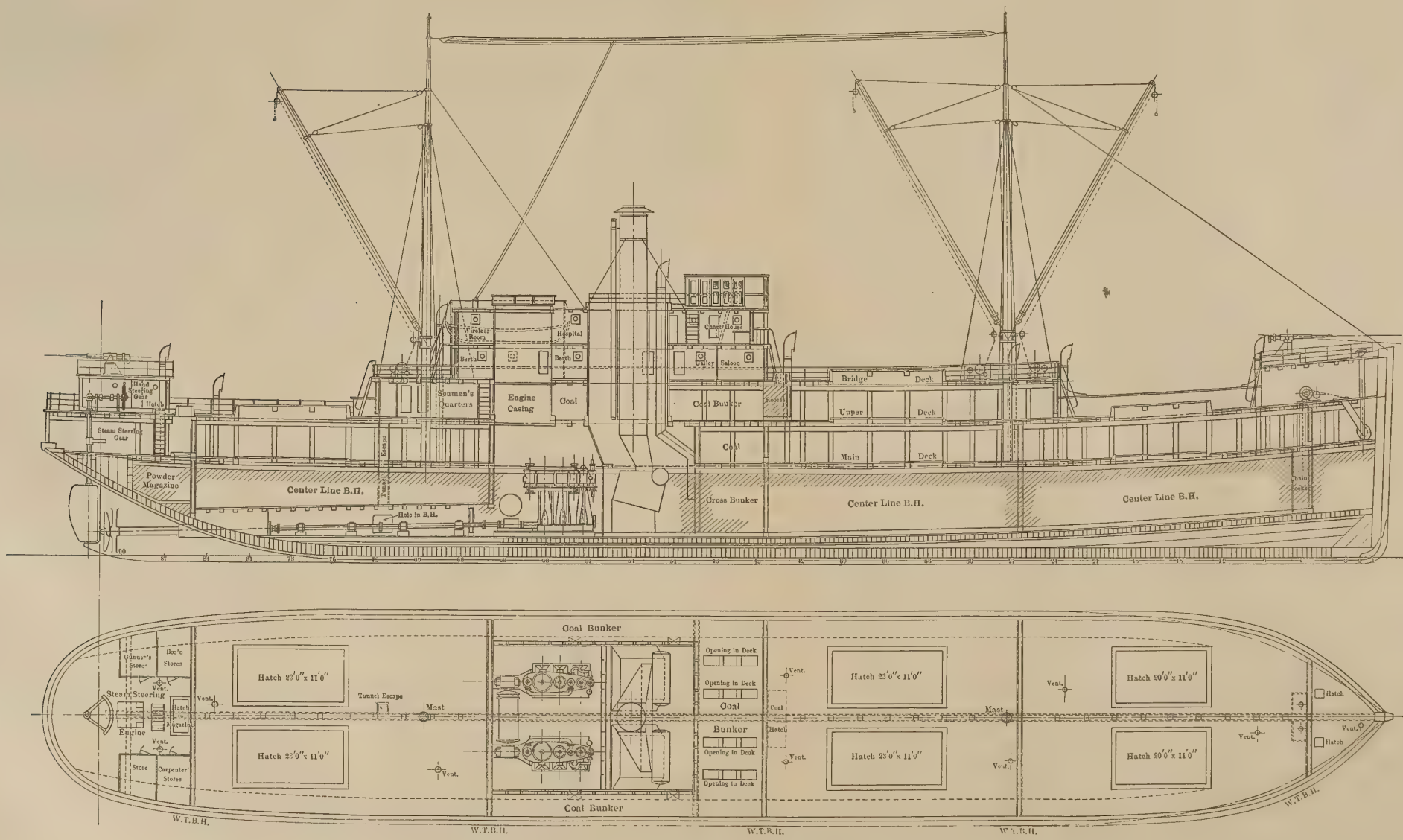


Fig. 2.—Inboard Profile and Plan of Main Deck

much as possible and straight-line work has been substituted. For the greater part of the length of the vessel the sides are flat and the bottom V-shaped, with a deadrise of 3 feet. With this form of hull the majority of the frames are straight 12-inch by 12-inch timbers—a common stock size of timber, generally known as "mill run" lumber. As the sides and bottom are straight for the greater part of the length, most of the planking and ceiling is also straight-line work, and can be gotten out in a minimum of time and with a minimum of hand labor.

As the Hough design closely resembles that of a barge, the building of the ship will require very much less shaping and molding than is the case with the usual ship model. Not only are the timbers and planking for the most part straight, and therefore can be quickly and accurately cut at the mills, but also the fastenings and connections are such that time will be saved in checking and fitting the planks and timbers as compared with the ordinary ship form of vessel. An important advantage of the design is the fact that very little frame or surface dubbing will be required, and with the straight-sided machine-cut planking the calking can be more easily and quickly performed.

A raised forecastle deck and a house aft provide gun platforms, on which will be mounted rapid-fire guns for defense against submarine attack. Amidships is a bridge deck, above which is a boat deck, and in the midship deck houses all hands will be quartered.

General Arrangement

Propulsion is by two sets of triple-expansion reciprocating engines, supplied with steam by two boilers operating under forced draft. Geared turbine propelling machinery can be substituted for the reciprocating engines at the option of the builder.

The hull is subdivided by six transverse bulkheads in the 'tween deck space and five transverse bulkheads below the main deck. A double bottom extends from the forward collision bulkhead to the inboard end of the stern tube, and this is subdivided at the transverse bulkheads, as shown in the general plans. These spaces are used for water ballast and are piped for filling and emptying as usual.

A longitudinal centerline bulkhead extends the full length of the ship from the forward to the after collision bulkheads and up to the main deck. This bulkhead is built up of 6-inch by 8-inch edge-bolted material, faced on both sides with 4-inch by 12-inch planking worked diagonally and landing against a continuous sill at the top and bottom. This bulkhead is not calked and openings are provided as shown on the plans.

Cargo is handled through three sets of twin hatches by means of six cargo booms of 5 tons capacity each, fitted to the masts and served by steam winches.

Fresh water is carried in steel tanks stowed about the machinery spaces and at the stern of the ship. Provision is made for 80 tons of fresh water for boiler use and 30 tons for culinary purposes.

The vessel is thoroughly equipped with auxiliary machinery, including an electric light plant, steam winches, steam capstan, steam windlass, steam-steering gear with hand auxiliary, an ice machine, a steam-heating system and a pumping and drainage system.

Keel and Keelsons

The keel consists of a timber, 12 inches by 18 inches, in long lengths fastened with 1¼-inch headed bolts set up over clinch rings at the bottom. The keel is fastened to the center keelson and to the top floor timbers as follows: In each bay one 1⅛-inch drift bolt driven from the inside and clinched over a ring outside; in each bay two 1¼-inch headed bolts driven from the inside and clinched over rings on the bottom of the keel; at each frame two 1⅛-inch drift bolts are driven from the inside and clinched over rings outside.

The keel is protected by a shoe 3 inches thick by 18 inches wide.

Stem and Stern Post

The stem, sided 18 inches and molded 24 inches, is 46 feet long and scarfed to a natural knee at the forefoot. A half round iron band, 5 inches wide, extends from the stem head down to 2 feet below the light waterline, and is wrapped over and fastened to a ¾-inch by 10-inch flat band extending around the forefoot over the keel split and spread at the end. The apron, sided 18 inches and molded 24 inches, is in one length, extending to the forecastle deck. The knightheads are in one length to the forecastle head, sided 24 inches and molded 12 inches. A natural knee connects the stem to the keel and the deadwoods are chocked into the keelson and apron.

The stern post is 48 inches fore-and-aft and 18 inches wide, bearded aft near the rudder to 12 inches wide. The bottom is fitted with a cast-steel shoe, carrying the bottom rudder pintle and the top is chocked solid at the deck beams and kneed off sideways. A rudder trunk is built on the after side of the post, fitted with a round lead sleeve turned over and made tight top and bottom. A cast-steel bearing ligned with lignum vitæ is placed at the bottom of the sleeve and a cast-iron stuffing box at the top. The after deadwoods are worked diagonally, as shown in the plans, a natural knee being fitted at the junction of the keel and stern post. Two horn timbers, 18 inches by 20 inches and about 24 feet long, are placed one on each side of the stern post connecting with the rim and landed on the frames.

The rudder is built up of two ½-inch steel plates set apart 24 inches, stiffened by horizontal web plates and angles. The rudder stock is of forged steel.

Framing

The side frames are double, 12 inches by 12 inches, spaced 36 inches centers throughout and extending from the bilge to the upper deck. In the way of the bridge house they are single, one leg of the frame being in one length from the bilge to the upper deck, the lower end of the leg butting and the other lapping the transverse floor timbers.

Cant frames, of the same siding and molding as the main frames, are built up at the ends of the vessel and well fitted to the deadwood.

The bottom floor timbers are double, 12 inches by 12 inches butted, as shown on the drawings and secured by an anchor stock piece the same width as the frame. The top timbers are single, except under the machinery, and are 12 inches by 12 inches in one length.

The bottom timbers and heels of the frame are fastened together by two 1-inch screw bolts, each with plate washers under the head and nut. At the heels of the frames the bays are chocked and made watertight with a stop-water at each side of the chock, shutting off the bottom from the side spaces. Each anchor stock piece is fastened to a bottom floor timber by two 1⅛-inch screw bolts each side of the center.

Under the machinery the top floor timbers are doubled and the spaces between the top and bottom floor timbers are chocked in solid.

The side ceiling is 10 inches by 12 inches, the three up

and bottom strakes being scarfed 7 feet. The bilge ceiling consists of four strakes 10 inches by 12 inches and one strake built up of two pieces 10 inches by 18 inches with 8-foot laps. All four strakes are edge-bolted and fastened to the floors. The first two strakes are edge-bolted to the bilge log.

Planking

The garboard strake is 8 inches by 16 inches edge-bolted to the keel, with 7/8-inch iron in alternate frame spaces. It is fastened to every frame with four 1-inch by 20-inch buttonhead bolts with the heads countersunk and cemented.

The bottom and side planking is 5 inches thick, varying from 16 inches in width at the garboard to 12 inches at the bilge and from 12 inches to 10 inches at the sides. Several strakes of 6-inch planking are provided at the bilge and wales, as shown on the midship section.

Iron Strappings

In addition to the longitudinal and transverse bulkheads and double bottom, the hull is further strengthened by iron strappings which extend from well forward of No. 1 hatch to abaft of No. 3 hatch. Diagonal iron straps, 1/2 inch by 4 inches, are let into the outside of the frames and inclined at 45 degrees each way. These are fitted so as to meet at the top butt in every other frame space.

The diagonals are connected at the top butt by two 7/8-inch rivets and at each crossing by one 1-inch fitted bolt. They are also fastened to each frame timber by a 1-inch by 10-inch counter-sunk head blunt bolt. The bottom is securely fastened at the bilge corner.

Decks

At the main and upper decks are clamps and shelves built up as follows: The clamp at the main deck is 14 inches by 16 inches, the shelf consisting of four strakes each 10 inches by 12 inches; two strakes being locked 2 inches into the beams. The upper deck clamp is 12 inches by 14 inches, while the shelf strakes, of which there are four, are 8 inches by 12 inches.

The upper deck beams are 12 inches by 14 inches, spaced about 36 inches centers and have a 7-inch camber. They are doubled at the hatch ends and boiler openings. Half beams are landed on a fore-and-aft sill, 4 inches by 14 inches, and pulled up to the deck coamings by screw bolts.

The main deck beams are 14 inches by 14 inches, spaced about 48 inches centers doubled at the hatch ends. The main deck ('tween deck) is laid solid with 4-inch by 8-inch planking and calked.

Tie Rods

Tie rods, 1 1/2 inches diameter, are fitted from the sides of the vessel to the hatch sills at the upper and main decks. Two are provided in way of each hatch. At the hatch end and at every fourth beam between hatches the tie rods extend clear across the vessel and are fitted with turnbuckles.

Web Frames

Web frames are built in at the hatch ends and elsewhere spaced about 9 feet centers. They consist of vertical pieces butting against the knee at the bilge corner and the upper deck and are fastened together so as to make solid work.

Two of the distinctive features of this vessel, the central longitudinal bulkhead in conjunction with twin hatches and the construction of the bottom, have been patented by the designer.

Salvage of Floating Dry Dock Driven High and Dry on River Bank in Storm

BY G. J. DELACROIX

DURING the hurricane of July 5, 1916, a floating dry dock, in which the steam tug *Gulfport* was undergoing repairs, was blown from its moorings at the plant of the Ollinger & Bruce Dry Dock Company, Mobile, Ala., and drifted about two miles up the Mobile river, finally being driven high and dry on the west bank of the river, as shown in Fig. 2. The dock was in three sections and the tug rested on the keel and bilge blocks of the two after sections, the bow of the tug extending on to the third or forward section.

Difficulties were encountered in salvaging the dock, because of the fact that many barges and other floating property had been jammed on the bank of the river in

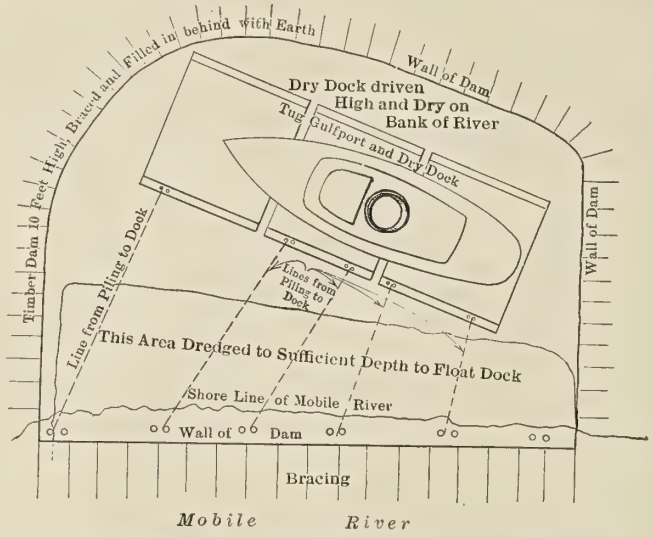


Fig. 1.—Sketch Showing Method of Salvaging Dock

front of the dock. The work was undertaken by the Jett-Muth's Construction Company, Inc., and successfully accomplished within a comparatively short time. The method of salvaging the dock is indicated in the diagram, Fig. 1. A channel was dredged parallel to the river, and as close to the dock as was practical. Then six clusters of piling, each cluster consisting of two piles, were driven along the shore line of the river, as indicated in the sketch, and lines were run from the clusters of piling to the dock, which were to be used for hauling the dock into the channel. A timber dam, 10 feet high, was then built, surrounding the dock, the dredged channel and piling. The dam was braced from without with timbers and then filled in with earth to add strength.

Water was pumped into the inclosure formed by the dam until the dock was afloat, then the lines from the piling were set up taut and the dock hauled alongside the piling. After this, holes were cut in the dam and the water in the inclosure allowed to recede to the level of the river, the dock floating in the dredged channel. The dam was then torn away and the dock, still holding the tug, was safely towed back to the plant of the Ollinger & Bruce Dry Dock Company.

During all these operations the tug *Gulfport* was not displaced from its keel and bilge blocks in the dock until after the dock had been floated back to the repair plant and repairs had been finished on the tug.

SALVAGE OF STRANDED DRY DOCK AND TUG AT MOBILE

Work Carried Out by Jett-Muth's Construction Company, Inc.

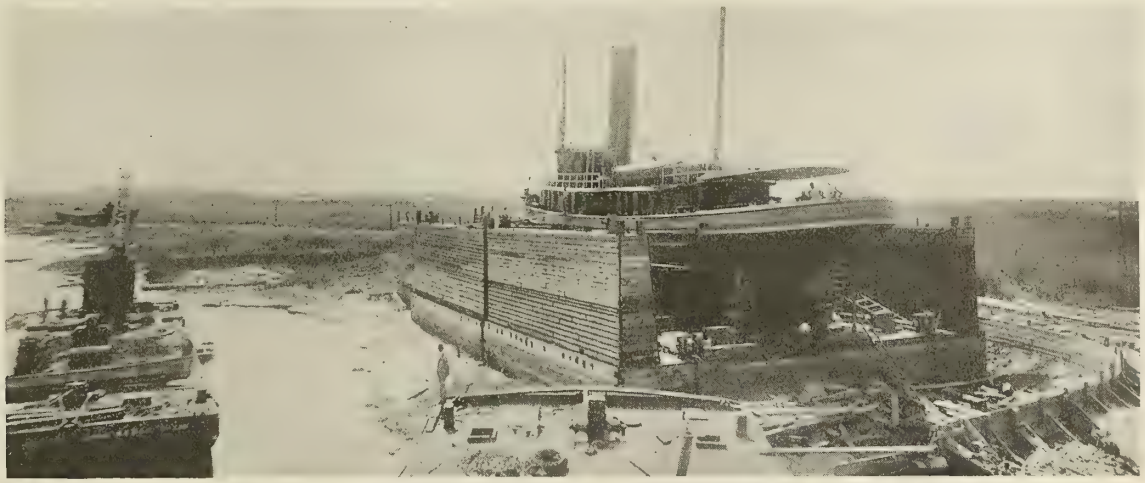


Fig. 2.—Dredging a Channel Alongside Stranded Dock

Fig. 3.—Timber Dam, Enclosing Dock and Dredged Channel

Fig. 4.—Inclosure Filled with Water and Dock Floated into Dredged Channel

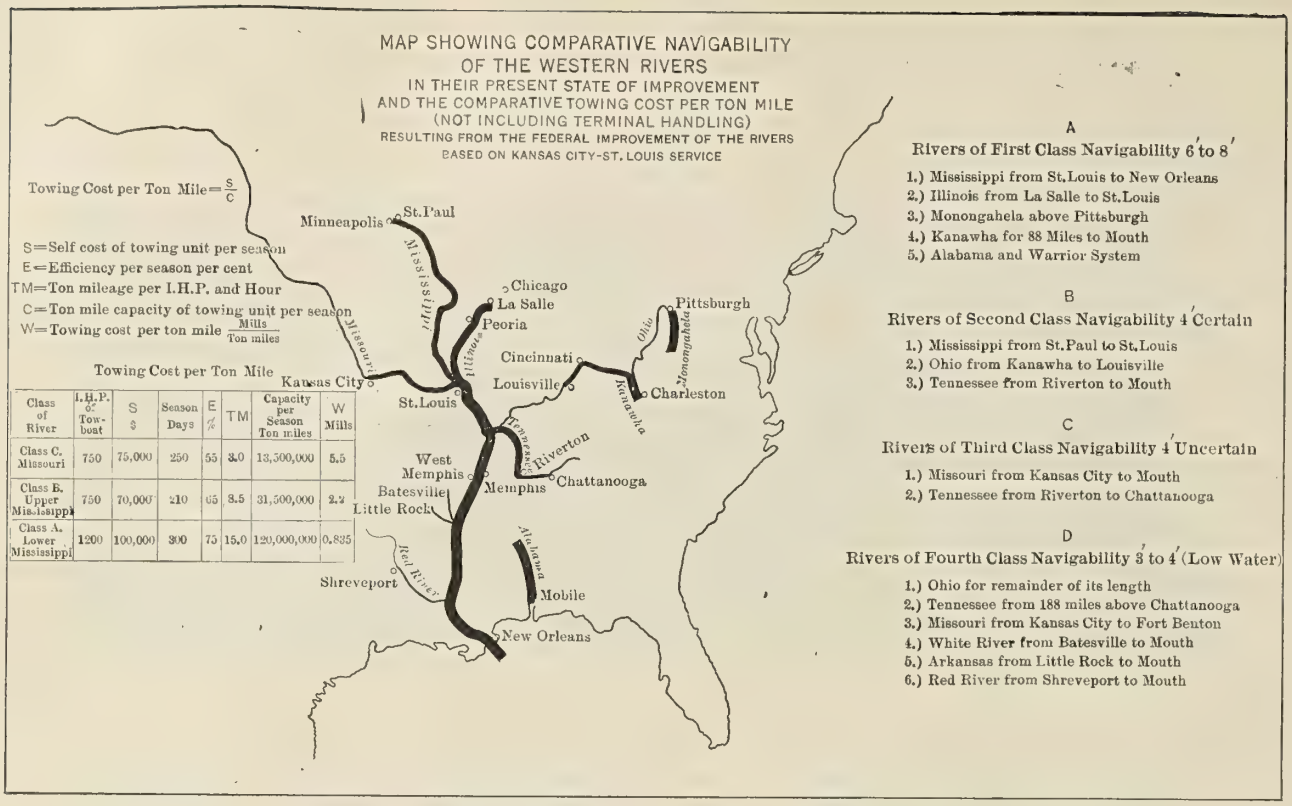


Fig. 1.—Map Showing Comparative Navigability of Western Rivers

Towing Costs on Western Rivers

Investigation of Factors Which Influence Cost of Towing—Towing Equipment and Formation of Tows—Cost Data

By M. von Pagenhardt *

THE towing cost is obviously a function principally of the depth of channel and the current velocity, but we shall endeavor in the following article to determine their correct influence together with the secondary influence of wages, fuel, repairs and fixed charges, which make Western river towing such a peculiar problem.

The accompanying map (Fig. 1) shows the comparative navigability of the Western rivers in their present state of improvement. They are divided into four classes of navigability, no distinction being made between slack water of 6-foot depth and swift water of 8-foot channel depth, as, economically, they seem to balance.

In this first class, which we call class *A*, are the Mississippi below St. Louis, the Illinois below La Salle and the Monongahela, Kanawha and Alabama as far as provided with locks and dams.

In the second class, which we call class *B*, are the rivers with an assured 4-foot channel and a current velocity of less than 2.5 miles per hour, such as the upper Mississippi, the lower Tennessee and stretches of the Ohio.

In the third class, which we call class *C*, are the rivers with a shifting 4-foot channel and a current velocity of 3 miles and more, such as the Missouri below Kansas City and stretches of the Tennessee above Riverton.

In the fourth class are the rivers with an assured channel of 3 to 4 feet, with more or less current velocity, such as the Red, Arkansas, White, the Missouri above Kansas City, the upper Tennessee, stretches of the Ohio in low water, and many others.

This last class is not adapted to Western River towing, as the cost per ton-mile is in excess of the revenue per ton-mile fixed by competing rail rates. Only a combined passenger and freight service can financially succeed. We shall not deal here with this problem.

Towing service is analogous to railroad through-freight service. It must compete with railroad rates established between water points. It must maintain a differential water rate below this already lowered rail rate and it must, as a rule, absorb heavy terminal switching charges. This cannot be accomplished in individual small efforts, but only by a properly dimensioned undertaking.

The operating cost of a towing service with towboats of equal power is practically the same all over the Western rivers, while the revenue depends on the amount of tonnage which can be transported up- and down-stream in a practical tow formation in the respective channels in a given time. The balance can only be drawn after the completion of an average round trip or at the end of a season.

Capacity and Efficiency of a Towboat

The towing capacity of a towboat is practically the same down-stream as up-stream. One is led to believe that a towboat can take more pieces down than up, but in

* Naval architect, Kansas City, Mo.

reality this greater down-stream haul is without financial advantage, as corresponding time is lost in the round-trip movement, for the towing capacity is a product of tonnage and mileage and this product is practically constant for a given class of river.

The tonnage moved by a 750 horsepower Mississippi towboat might be 3,000 tons and the speed up-stream 3.5 miles per hour and down-stream 9 miles per hour. The average speed during the round trip is then:

$$\frac{2 \times 9}{1 + \frac{9}{3.5}} = \frac{18}{3.57} = 5$$

miles per hour (approximately) and the average ton-mile capacity is 15,000 ton-miles per hour. This product is constant. If more pieces are hooked onto the tow with additional tonnage, the speed will be decreased proportionately and the capacity will remain 15,000 ton-miles per hour.

Also, the towing capacity of a towboat must be a function of the horsepower or the pushing power of the towboat; it must vary with the channel depth and the channel width; it must vary with the current velocity; it must finally depend on the percentage of operating efficiency which can be attained in the particular class of river; by this, we mean the ratio of total hours of service and the actual running hours, which varies from 50 to 75 percent.

Capacity Miles

By observation, we find the following facts to govern towing service in the three classes of rivers:

(1) Rivers of Class *A*.—A towboat can push 4 tons per horsepower and maintain the required speed of 5 miles per hour or develop a ton-mileage of 20 ton-miles per hour per horsepower. The operating efficiency should be 75 percent. The average capacity is, therefore, 15 ton-miles per hour per horsepower per season.

Example.—A 750-horsepower towboat operating in the lower Mississippi has a daily capacity of 270,000 ton-miles, and in a season of 300 days a capacity of 80,000,000 ton-miles. A 500-horsepower towboat operating in the Monongahela has a daily capacity of 180,000 ton-miles, and in a season of 300 days a capacity of 54,000,000 ton-miles. The towboats in actual service transport coal down-stream only and have no return freight. Their ton-mile capacity should be, therefore, better than 27,000,000 ton-miles per season, as they gain time going light up-stream. Their actual ton-miles capacity is stated as 30,000,000 ton-miles per towboat per season and 100,000 ton-miles per day.

(2) Rivers, Class *B*.—A towboat can push 2 tons per horsepower and maintain a speed of 6.5 miles per hour, or can push 2.6 tons per horsepower and maintain a speed of 5 miles per hour. The capacity is 13 ton-miles per horsepower per hour and an operating efficiency of 60 to 65 percent can be maintained. The average capacity is, therefore, 8.5 ton-miles per horsepower per hour per season.

Example.—A 750 horsepower towboat operating between St. Paul and St. Louis can transport 1,500 tons per trip and maintains a daily capacity of 150,000 ton-miles, or reach in a seven-month season a capacity of 31,500,000 ton-miles.

(3) Rivers, Class *C*.—A towboat of 750 horsepower can push 1 ton per horsepower and maintain a speed of 6 miles per hour, or 1.2 tons per horsepower, and maintain a speed of 5 miles per hour. Her capacity is 6 ton-miles per horsepower per hour. An operating efficiency of 50 to 55 percent can be maintained. The average capacity is, therefore, 3 ton-miles per horsepower per hour per season.

Example.—A 750 horsepower towboat operating on the Missouri between Kansas City and St. Louis can maintain a daily capacity of 54,000 ton-miles and in a season of 240 days a capacity of 13,000,000 ton-miles.

Daily Capacity a Predeterminable Amount

The capacity of a 750 horsepower towboat is, therefore, a predeterminable amount, varying from 54,000 ton-miles per day in class *C* rivers to 150,000 ton-miles in class *B* rivers to 270,000 ton-miles in class *A* rivers, or varying in the ratio of 1 to 2.8 to 5.0.

Determination of the Towing Unit (See Fig. 2)

The towing unit is the combination of towboats and barges, with barges for exchange and reserve, with lighters for shallower rivers, and its percentage of harbor tugs, repair yards and other equipment. The towing unit represents a value of $250,000 (£51,300) in any class of river. Equipment for class *C* consists of the same number of pieces practically as equipment for class *A*, and is only less deeply loaded. Equipment for class *A* rivers must

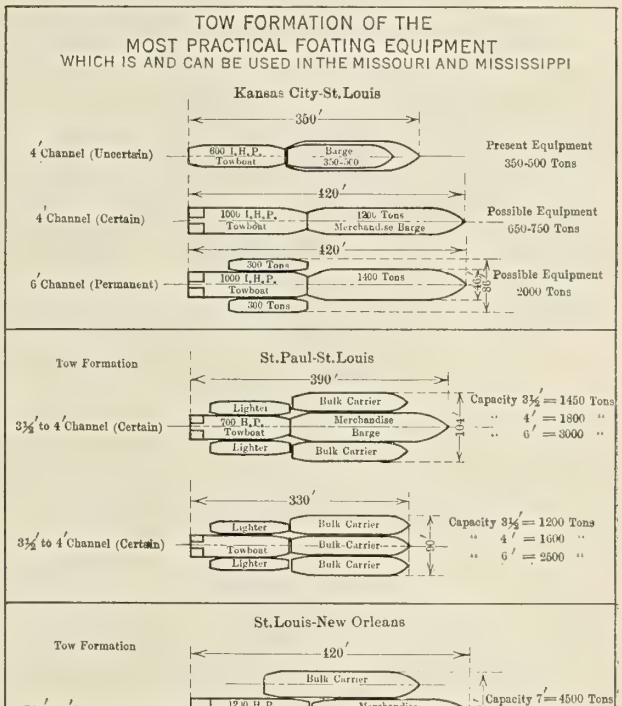


Fig. 2

have capacity for a tonnage equal to 4 or 5 times the horsepower; equipment for class *B* 2 to 2.5 times the horsepower; equipment for class *C* rivers 1 to 1.5 times the horsepower.

In reality a combination between barges and lighters is desirable. The lower Mississippi towing unit consists preferably of three large barges drawing 8 feet. The canalized river towing unit consists preferably of two large and one small barge drawing 6 to 7 feet. The upper Mississippi towing unit consists preferably of one large barge, two small barges and two small lighters spreading out, as it were, in the slack current of the 4-foot channels. The swifter Missouri, however, calls in its best equip-

ment for a single large barge and only possibly two lighters which can be double tripped through narrow places of excessive swiftness. All merchandise barges should be designed with a view of the future deeper channel of possibly even 9-foot depth; they should be readily exchangeable and their lines should be in accordance with a design of least resistance.

The number of towing units is determined by the distance between terminal points, which varies from 50 to 2,000 miles. A single unit is commercially possible in a short trade of 50 to 250 miles, but, as a rule, one unit is required for each 100 to 125 miles of river, so as to maintain a service of not exceeding two to three days' interval. A towing service between St. Louis and New Orleans,

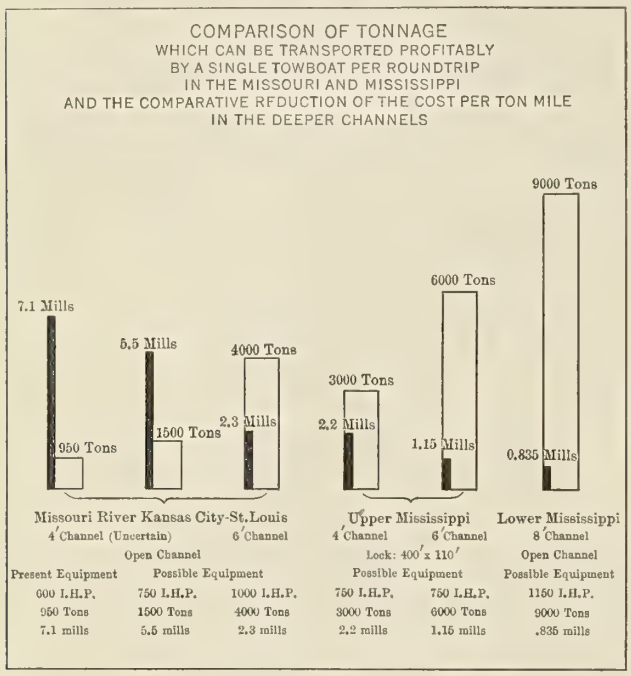


Fig. 3

distance 1,242 miles, requires 10 units; a service between St. Paul and St. Louis, distance 677 miles, requires 6 units; a service between Kansas City and St. Louis, distance 408 miles, requires 3 to 4 units. The fixed charges on this equipment are 3 percent for repairs, 3 percent for depreciation and insurance, 6 percent for interest on investment and 3 percent for overhead, or a total of 20 percent of $250,000 (£51,300), or $50,000 (£10,250) per unit per season.

Cost of Towing Service

Only two items compose the cost of the towing service:

(1) The cost of operation of the towboat, which for a 750-horsepower towboat of correct construction is $100 (20/16/8) per day (although there are antiquated boats which cost twice the amount per day), increases with the increase in horsepower, ranging from $80 (16/13/4) per day for a 500-horsepower towboat to $130 (27/1/8) per day for a 1,200-horsepower towboat, at the same time decreasing in cost per horsepower. A 750-horsepower towboat, with its daily cost of $100 (20/16/8), half of which is for fuel and the other half for wages, commissary and supplies, will maintain this daily cost in all classes of Western rivers, due to the well-balanced fuel conditions existing. The operating cost per unit is, therefore, constant for all classes of rivers and only variable with the amount of horsepower applied in the towboat and the length of the navigable season.

As an example of class *A*, take the lower Mississippi, with a 300-day season; of class *B*, the upper Mississippi, with a 210-day season, and of class *C*, the lower Missouri, with a 240-day season.

(2) The fixed charges being in either case $50,000 (£10,250) and the operating charges for class *A* $30,000 (£6,150), class *B* $20,000 (£4,100), class *C* $24,000 (£4,920), we have a total cost per season of $80,000 (£16,400), $70,000 (£14,320) and $74,000 (£15,140), respectively, with a corresponding ton-mileage capacity of 80,000,000 for class *A*, 31,500,000 for class *B* and 13,000,000 for class *C*, which gives us the self-cost per ton-mile: 1.00 mill for class *A*, 2.2 mills for class *B* and 5.5 mills for class *C*.

Reduction of Self-Cost for Class A

This self-cost can only be reduced for class *A* by selecting larger towboats and larger towing units. The larger towboat unit, one of 1,000 to 1,200 horsepower represents with all its towing equipment a value of $300,000 (£61,500), or a yearly fixed charge of $60,000 (£12,300). The cost of operation increases to $130 (21/1/8) per day or in a season of 300 days to $39,000 (£8,000). The total self-cost per unit is therefore increased to $99,000 (£20,300). The ton-mile capacity, however, is increased to 120,000,000 ton-miles per season, and the self-cost is reduced to .825 mill per ton-mile, or 17.5 percent.

Improvement of the Western rivers accomplishes an automatic reduction of the ton-mile self-cost in the same ratio as the improved rivers advance from a lower class into a higher class. The upper Mississippi, with its 4-foot channel, now in class *B*, would advance with a 6-foot channel to class *A* and, but for the difference of operating efficiency, the ton-mile capacity and self-cost of class *A* would apply. The improvement of the lower Missouri to a depth of 6 feet will put this channel from class *C* into class *B*, and the class *B* rates will generally apply.

Fig. 3 shows a comparison of ton-mile capacities and self-cost of the possible towing units in the Missouri and Mississippi in graphic form.

(1) Missouri River.—In its present state of improvement and with the present 600-horsepower towing units in use the capacity per season is 10,800,000 ton-miles and the self-cost 7.1 mills per ton-mile. A possible 750-horsepower unit would have a capacity of 13,000,000 ton-miles and reduce the self-cost to 5.5 mills.

After its improvement to 6-foot depth a possible 1,000-horsepower unit would have a capacity of 36,000,000 with the self-cost reduced to 2.3 mills. The maximum improvement of the channel from its present to its proposed condition would, therefore, increase not only the ton-mile capacity of the present towing unit but permit the use of a larger towing unit, resulting in a reduction of the self-cost in the ratio of 1 to 3.

(2) Upper Mississippi.—The best equipment possible in this river, a 750-horsepower towing unit, would have a yearly ton-mile capacity of 31,500,000 ton-miles with a self-cost of 2.2 mills. The same equipment after the improvement of the river to a 6-foot channel depth would have double the ton-mile capacity, reducing the self-cost by one-half.

(3) Lower Mississippi.—The 750-horsepower towing unit has in this river a capacity of 80,000,000 ton-miles per season with a self-cost of 1 mill per ton-mile. A possible 1,200-horsepower towing unit would have a capacity of 120,000,000 ton-miles per season with a self-cost of .825 mill per ton-mile.

Cost of Down-Stream and Up-Stream Towing

The up-stream cost, as a rule, is 50 percent greater than the down-stream cost or the down-stream is two-thirds of

the up-stream cost; or the down-stream cost is 40 percent and the up-stream cost 60 percent of the round-trip cost. Applied to class *A*, the down-stream cost per ton-mile is .66 mill and the up-stream cost .99 mill. Applied to class *B*, the down-stream cost per ton-mile is 1.75 mills and the up-stream cost 2.64 mills. Applied to class *C*, the down-stream cost per ton-mile is 4.4 mills and the up-stream cost 6.6 mills per ton-mile.

Earning Power of a Towing Unit

The earning value of a towing unit depends first on the ton-mile capacity and second on the revenue per ton-mile. Anticipating water competition, railroads paralleling rivers have reduced rates between water points to such an extent that only a towing service offering lower rates and correspondingly good service can compete. Properly-dimensioned towing units or towing trains have a 5,000-ton capacity, or two and one-half times the capacity of the largest freight trains. The self-cost of towing is in class *A* reduced to .66 mill per ton-mile down-stream and .99 mill per ton-mile up-stream. One towing unit for each 100 miles of river guarantees a service of two- to three-day intervals. The self-cost of transportation in rivers of class *A*, .66 mill per ton-mile down-stream and .99 mill per ton-mile up-stream is far below the self-cost of rail transportation.

Average revenues obtainable on rivers of class *A* are not less than 2 mills per ton-mile, on rivers of class *B* 3.5 mills per ton-mile, and in rivers of class *C* 7 mills per ton-mile, leaving a 25 percent margin on rivers of class *C*, a margin of over 50 percent on rivers of class *B* and a margin of over 125 percent on rivers of class *A*.

Shed Capacity at Marine Terminals

Proportions of Quay and Pier Sheds to Give Most Efficient Service—Prevention of Congestion in Sheds

BY H. MC L. HARDING *

IT has generally been the practice to design piers the widths of which were determined chiefly by the available water area. The pier was often made too narrow for the length, the idea being that as many piers and as much berthing frontage as possible should be obtained without regard to other equally important considerations.

Similarly, the widths for the ships were often contracted to the narrowest limit. The natural result followed, viz.: great congestion on the piers and approaches, in the sheds and in the ships, which more than nullified any advantages of the increase in berthing frontage.

There were no general rules to follow, and each engineer was a rule unto himself. After the pier was planned, the floor dimensions of the shed were made to fit the pier —that is, as much of the pier as possible was covered by the shed to within a few feet of the sides of the pier. The height of the shed was generally fixed by custom at about 16 to 18 feet, unless there should happen to be two stories. There were frequently drayways and car tracks within the sheds.

Holding Capacity of Shed

There seemed to be no conception as to what relation should exist between the holding capacity of the shed and the size of the vessels making use of the piers and shed. Even the proper function of the shed, which is a place only for assorting, distributing and tiering the cargoes and freight for short holding and not as a warehouse for long storage, did not seem to be fully recognized. To the lessee or owner of the shed it could have been said: "There is the shed, use it." If the shed was soon filled up with freight and there was the too often unnecessary congestion, the congestion must be endured or else another pier and another shed must be built. Quay sheds, even where there was ample room, were designed to conform to some customary sizes. Apparently, as quay sheds at a neighboring port had certain dimensions, such sheds were taken as models and imitated.

It is the object of this paper to ascertain whether pier sheds cannot be designed with reference to their greatest usefulness, and in other ways prevent the excessive shed congestion. In an address before the American Society of Mechanical Engineers in 1913, the chief engineer of the port of Hamburg stated that the practice at Hamburg was to have the capacity of the shed equal to twice the average capacity of the largest ship berthing in front of the shed, and that the length of the shed was about equal to that of the longest ship. This referred to ocean freighters with ships berthing on one side of the shed. This result was derived from careful observation and study of a large merchant marine.

Number of Vessels Served by Shed

It is evident that there should be a greater capacity for sheds on piers where there may be a vessel on each side of the pier opposite the shed than for quays where there is a vessel only on one side of the shed. That is, the one shed on a pier should have a capacity for four ships instead of two, if congestion is to be avoided.

On piers of such a width that there can be two sheds abreast with a space between them, each shed should have the same capacity as a quay-shed. This is the case at Kobe, Japan, being the design of English terminal engineers.

Where there is a large tonnage of both inbound and outbound freight, it is often advantageous, where conditions will permit, to have one shed for outbound freight and another for inbound cargoes. This has given excellent results.

While a certain proportion of the cargo of a barge may be for railway car loading, or for immediate direct transference to drays, yet there may be vessels the whole cargo of which may require shed protection without immediate car or dray transference and often there must be not only the inbound cargo in this shed but also outbound cargo, held for loading into barges or ships. With only one shed the outbound cargo should be tiered in that portion of the shed nearest the barge, and the inbound on the opposite side of the shed nearest the railway tracks and the dray area.

There are locations having ample water frontage, but where, due to shallow water, too much dredging would be

* President of the Society of Terminal Engineers, New York City.

required for economical quay development. A long pier, 250 feet or even more in width, would be preferable, with two sheds abreast with a wide space between, to which reference has been made.

While there are many indeterminate factors as to shed capacity, yet fortunately the shed being designed for short holding and not for a warehouse, the time the freight can be held in the shed can be so limited as to greatly reduce congestion under ordinary conditions. It is recommended that the freight be held in the shed not more than forty-eight hours. If the freight be not moved by the consignee at the end of this forty-eight hours, it is then sent to the warehouse for storage, the expense for handling, transferring and storage being charged against the shipper, consignee or the goods. By giving this limit of forty-eight hours the authority of law, it will obviate discussion and congestion, thereby reducing delay and eliminating re-handling costs, and may render unnecessary the immediate building of additional terminal sheds.

For comparison as to the relative capacities of barges and pier sheds the following figures are given:

Relative Capacities of Barges and Pier Sheds

The net cubic foot capacity of a barge about 300 feet long, 42 feet wide and drawing about 11 feet, and limited to 15 feet head room under bridges, may be taken as 40 feet by 280 feet by 20 feet = 224,000 cubic feet. The gross shed capacity should therefore under these conditions be 300 feet by 80 feet by 20 feet, which equals 480,000 cubic feet, which is about double the barge capacity of 224,000 cubic feet. If the shed should be made 400 feet long, its capacity should be 640,000 cubic feet.

The vertical capacity is here attained by high mechanical tiering, which is by far the most economical method for increasing shed capacity. No floor space should be occupied by the tiering machinery or by railway tracks or for drays. The usual height of 5-foot tiering by manual labor would only give 120,000 cubic feet, which is only one-fourth the required capacity. Any higher tiering by manual labor than 5 feet so increases the cost of handling that any higher tiering is avoided whenever possible.

Pier shed capacity for a properly designed pier is independent of the length of the pier, the same as a quay shed is independent of the length of the quay. Longitudinal travel by cars or drays is kept outside the sheds, and similarly between the shed and the waterfront.

The above figures of capacity in the shed design can be adjusted and regulated by the time allowed for the freight to remain in the sheds, and the length, breadth and height of shed can be varied proportionately depending upon the volume of cargoes.

The sheds for freight (not for passengers, which often should be of two stories) should be of one story. One story with high tiering will give greater freight capacity and less costs for supervision and handling than where there are two stories. The initial investment will be much less.

As to inland lake or river freighters, the following data may be of service:

Freight, Tons	Length, Maximum Feet	Beam, Maximum Feet	Draft, Feet	Shed Capacity, Cubic Feet
2,000 to 3,000.....	365	50.	19.9	400 x 60 x 20
5,000 to 6,000.....	436	56.	20.3	450 x 80 x 20
9,000 to 10,000.....	500	56.2	20.9	500 x 80 x 20

If the length of the ship should be 320 feet, then the length of the shed may be that of the next above multiple of fifty—that is, 350 feet. The character of the cargo is that which would require shed protection and does not refer to ore, coal or coarse freight.

It will be noticed from the above that to get carrying capacity the length and beam is increased while the draft on account of the locks is not. For 9,000 to 10,000 tons the draft is 20.5 feet and for 15,000 tons it is only 20.8 feet. For ocean freighters the draft is more and the beam less.

Where there are two ships or barges, one on each side of the pier, then the length of the shed should be 50 percent longer than the longest vessel, with a width of 80 feet, and the height of tiering 20 feet. If the longest vessels to berth there should be 500 feet, with a miscellaneous cargo capacity of 5,000 tons, the shed dimensions should be

$$\left(500 + \frac{500}{2}\right) \times 80 \times 20 = 1{,}200{,}000 \text{ cubic feet.}$$

Making due allowances for aisles and working space, the ton may be assumed to occupy 60 cubic feet instead of the marine 40 cubic feet; therefore 5,000 × 60 = 300,000 cubic feet, and multiplied by four for the two ships would give 1,200,000 cubic feet.

Conclusions

1. A quay shed should have a cubic foot maximum capacity double the average freight-carrying capacity of the largest vessel expected to berth opposite to it.

2. A pier shed having a berth for a ship only on one side of the shed should have the same maximum capacity as a quay shed.

3. A pier shed having berths to be occupied on both sides of the pier opposite the shed should have a shed fifty percent longer than the longest vessel, giving approximately a capacity double the average freight capacity of both vessels combined, or four times the cubical capacity of one ship.

4. Unless there are freight-holding capacities approximating to the above, under average conditions there will be the usual congestion and the most efficient use of the shed will not be attained.

New Naval Dry Dock at Norfolk.—Plans for the new graving dry dock to be built at Norfolk, Va., call for a dock 1,000 feet long and 110 feet wide, with a depth of water of 43 feet 6 inches over the sills. The sills are 2 feet above the floor and the blocks along the floor are 5 feet 6 inches high, spaced 2 feet apart. The dock is to be closed at the end by a caisson and provision is made for an intermediate caisson which will divide the dock into two separate sections, one 650 feet long and the other 350 feet long. As the largest vessels in the Navy up to date, with the exception of the battle cruisers now being built, are less than 650 feet long, the larger part of the dock can be used for the larger ships while the smaller part can be used at the same time for smaller craft. The pumping plant of the dock is in separate units and the dock can be pumped out in one and one-half hours when no vessel is in the dock. It can be flooded in thirty minutes. The caissons are provided with equipment for flooding and pumping out the caissons themselves, the flooding of the dock being accomplished through numerous openings controlled by hydraulically-operated quick-acting valves. The pumping equipment in the caissons is electrically operated and designed so that the water can be pumped out of the caissons in fifteen minutes' time. A 50-ton electric crane equipped with a horizontal jib will travel around the dock. Electric capstans will be provided for handling the lines when docking a vessel.

Mold Loft Notes

Methods of Developing Shell Plating — Lifting Bevels

BY T. L. COHEE

Definitions of Terms Used in Mold Loft

Tumble Home.—The distance the side of the ship falls inboard from the half-beam perpendicular in way of deck.

Flam.—The opposite of tumble home, that is, the fall out of the ship's side, which usually occurs at ends of ship.

Bow Line or Buttock.—The molded shape of the ship through a vertical plane parallel to the longitudinal center line.

Diagonal.—The molded shape of the ship through an oblique longitudinal plane extending from the center of ship to the middle of bilge on the midship frame generally placed as near right angle as possible for fairing purposes.

Boss.—That part of the ship where the frames are swelled out to permit the passage of the ship's shaft tube.

Dead Flat.—The straightest part of ship's form and the greatest section midships and the point where the frames turn in opposite direction.

Camber of Beam.—The crown or curvature of the deck.

Bilge.—That part joining the ship's side to the flat of the bottom.

Length Between Perpendiculars.—The distance on the load waterline from the forward side of stem to the aft side of stern post.

Length Over All.—The level length from the extreme point of the stem to the extreme point of the stern.

Molded Depth.—The vertical distance from the top of keel—squared out to the side—to the underside of the main deck stringer plate at the midship section or lowest point of the sheer.

Midship Section.—The fullest part of the ship taken transversely and centrally between perpendiculars, but there are cases where it is nearer the stern than the stem. It is supposed to be the lowest point in the sheer.

Molded Beam.—The greatest width of the ship from the outside of frame to outside of frame or inner side of skin on the midship section.

Change of Frames.—The change of the position of frames occurs amidships; those in the fore body stand with the toe of frame facing toward amidship and those in after body likewise face amidship. This is done so as to always have an open bevel on the frame to facilitate riveting of frame to shell.

Cant Frames.—Cant frames are those which are not square to the center line of ship. They are always fitted aft of the transom and are sometimes fitted forward on very full ships.

Body Plan

The body plan is the shape of the ship at cross section planes at each frame section. These sections show a half side of the ship only. Those forward of the midship section are generally shown on the right-hand side of the vertical center line and form what is called the forward body. Those aft of the midship section are shown on the left-hand side and form what is called the after body.

The body plan is the basis of all development work. At some yards it is scribed in on a scribe board, which is made in sections of about 10 feet square, so that it may be portable, and is composed of two layers of well-dressed white pine lumber each about one inch thick at right angles to overcome warping and covered with lamp black for preservation. At other yards it is scribed in on the regular floor, usually at one end of the loft and shellacked for preservation and to keep the lines bright.

This plan shows in full size all the frame lines, the longitudinals, decks, shell, inner bottom, and projection of rabbet of stem and stern post. It also shows waterlines and sectional or buttock lines, from which the original laying down is done, sight edges of shell and inner bottom plating, traces of port holes and inner edges of longitudinals and stringers.

The fore-and-aft outlines of the stem and sternpost should be conveniently near, generally at each side of the body plan.

Method of Lifting Fore-and-aft Measurements from Body Plan

The body plan gives the true form of all the frames and shows the projection on the midship section, or a plane parallel thereto, of all other lines. The exact distance between any two points on the same frame is obtained directly from the plan.

The exact distance between any two points on different frames, however, is not so given, but is easily obtained, as

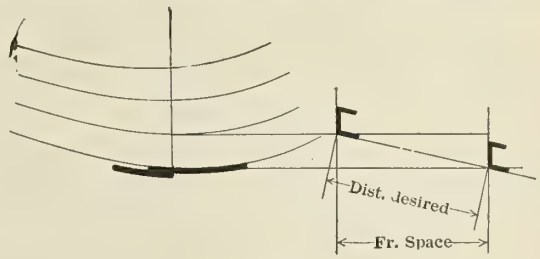


Fig. 1

shown on Fig. 1. The length of a line joining two points on two different frames is the hypothenuse of a right triangle of which one side is the projection of the line on the body plan, or the distance on the body plan between the two points, and the other side is the fore-and-aft distance between the two frames referred to, which is known from the frame spacing of the ship. Thus if the distance along a sight edge between two successive frames is desired, we measure the distance shown on the body plan between the intersection of the sight edege with the two frames and lay it down as the side of a right triangle of which the other side is one frame space. The hypothenuse is then the distance desired.

Templates

Templates are made of various materials, depending on the amount of use to which the template may be put. If for a pair of plates (port and starboard), the paper template is most convenient. For small brackets, clips and liners, or long angles, templates of wood are best, usually bass wood of about ⅜-inch thickness.

The template of any shape or plate is a full-size plan showing in detail all rivet holes and cut outs, outlines of

edges flanging or rolling lines and gives the necessary information for laying out.

The paper used for templates costs about $17 (3/10/10) per roll of 2,000 square feet, usually about 105 inches wide, but is also manufactured in other widths if desired. This paper expands and contracts according to the dampness,

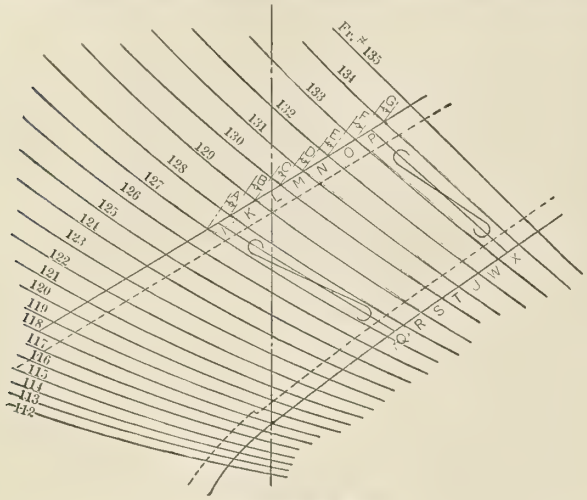


Fig. 2.—Body Plan

temperature, etc. For overcoming this fault a series of check lines, with length and breadth marks thereon, is placed on each template. When the template shrinks, caused by heat and dryness, the template is covered by a tarpaulin and water sprinklered thereon and the dampness allowed to permeate the templates. This method is better than sprinkling the water direct on the template, because if it is possible that the template may be used again for another ship later on the template will respond to treatment better.

It is the practice of the layerout to lay out all the plates at once rather than lay out one now and one a day or two later, especially if the template needs treatment. The paper does not respond to the wetting treatment the second time as well as the first time.

When the paper expands it is best brought back to its proper length by the application of heat, generally by standing it beside a steam radiator or on a furnace while rolled up loosely. By actual experience the temperature most suitable to keep the paper normal is about 60 to 70 degrees F.

The paper when subjected to the rays of the sun will shrink as much as ¼ inch before the layerout can finish center punching. For that reason it is best laid off in the shop. Recently at a certain yard on account of lack of shop space the plates were laid off on an open platform directly in the sun. To overcome this the work was laid off in the early hours of the morning, and laid off in the shop in the heat of the day.

Development Lines

In the development of a template certain reference lines must be obtained from the body plan and laid out in their relative positions, from which the details of the template can be laid out. These lines are the longitudinal plate edges of shell and deck, etc.

Detail plans of the sections to be laid should be convenient for filling in the details of the template; thus, when a template of a stringer is to be laid out, the framing plan, stringer plan, the shell expansion and similar plans should be on hand in order to place the rivet holes, cut out, etc., and the necessary information in detail essential for the laying out of template.

In the following description the detailed work of placing the width of laps, rivet lines and outlines of cut outs etc., will not be touched upon, as the method of doing this work is obvious, once the development work of obtaining the various lines on the template is done.

Fig. 3.—Shell Plate Developed by Squaring Method

Shell Plate Development—Squaring Method

The plate shown in body plan (Fig. 2) was taken from a section at about two-thirds length aft just after leaving

bilge. The developed plate (Fig. 3) is on the same scale as the portion of the body plan shown. The figure shows the actual development of a shell plate—not merely an illustration of how a plate is developed.

In developing a plate it is customary to develop the surface to the frame beyond each butt. In this case the surface between frames (127 and 134) is developed.

The first step is to draw a straight line from the top to the bottom of the edge of the plate at each frame, then from each of these lines square over to the next frame and note the distance above or below, as the case may be, in this case below. The differences on this plate were taken on the top or outboard edge, but could be taken on the lower or inboard edge of the plate just as well. Beginning at frame 127 and square over frame 128 (lifting distance *A*), and from frame 128 to 129 (lifting distance *B*) and so on, with each successive frame to frame 134 (distance *G*).

The next step is to lift the distances along the edge of the plate at the top and bottom on the body plan as at frame 127 to 128 shown as *J*, and from frame 128 to 129 shown as *K*, and so on, to frame 133 to 134 shown as *P*. Proceed in the same manner along the lower edge of the plate at *Q*, *R*, *S*, and so on. This, of course, is not the true length of the plate edges. Each of these distances represents the base of a right angle triangle, and the altitude is the frame spacing of the ship—in this case three feet. To get the right conception of this, imagine the body plan as a huge accordeon and open it out to its limit, each frame space (three feet) apart, then the line shown on the expansion of the outboard edge of the plate at *J-J*, *K-K* and *L-L*, etc., will be the true length along the top edge of the plate.

Proceed in the same manner to get the expansion of the inboard edge of the plate. Lift the distances on straight lines at each frame on the body plan. Lift also the actual girth of the plate on each frame—in this case there is not any practical difference. Having the girth at the respective frames, the difference in height of one frame to another and the length from one frame to another along the top and bottom edges, you are now ready to develop the plate in full size.

Begin by drawing a straight line and thereon place the girth of frame 127, then from this line at the top point erect a perpendicular line, produced a little greater than one frame space. Parallel from this line strike in distance *A*, then from the top point on frame 127 strike in distance *J-J*, intersecting distance *A* at frame 128. From this point strike in the girth of frame 128, intersecting *Q-Q* at the bottom edge of the plate. Proceed in the same manner with the others as shown.

It will be seen that the plate butts between frames 127 and 128 on the forward end and between frames 133 and 134 at the left end. The butt can now be placed at any point between the frames indicated by the shell plan and is measured square to frame and placed parallel to adjoining frame.

When the curvature of the frames is pronounced, that is, when the girth of the frame is in excess of the straight line drawn from the edge of the plate at the top to the edge of the plate at the bottom, as shown on the body plan, the excess is added equally to the edges of the plate after development.

Shell Plate Development—Triangulation Method

When shell plates are located some distance from the parallel middle body, that is, when their projection in the body plan has appreciable dimensions, their development is best obtained by triangulation. Fig. 5 shows the full development of a plate on an inside strake. The plate at the top shows how it appears on the shell expansion plan. The method of obtaining the length along the top and bottom edges is the same as explained on Fig. 3.

On the body plan (Fig. 4) a series of diagonals is struck in, as shown from 1 to 8. These diagonals represent the bases of right-angled triangles. The altitude is the frame spacing of the ship and the hypothenuse is the length desired. The diagram at the bottom of Fig. 5 shows the true development and method of applying the true distances.

Beginning at the left, on the vertical line marked frame 127, placing thereon the true girth of the frame, with this line as a base proceed by swinging in distance *J-J* at the bottom intersecting diagonal 1 at frame 128. From this intersection at the bottom of frame 128 erect girth of frame 128. Proceed in the same manner with the

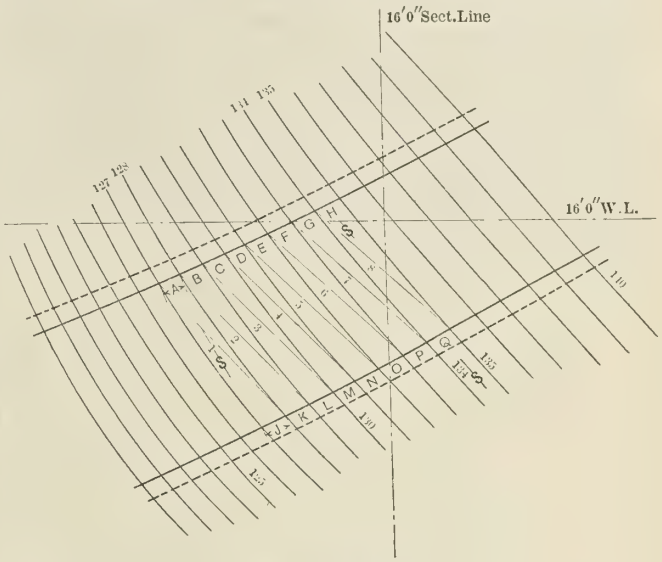


Fig. 4.—Body Plan

others. It will be observed that this plate is developed from sight edge to sight edge, and that to be complete the width of lap at the top and bottom edges should be added to the development.

It is better practice to check results by striking in the opposite diagonals, or take an opposite diagonal the full length of plate as at *A-B*.

Shell plating or longitudinals are best developed in long lengths, or in a continuous strake, rather than a single plate. This is governed, of course, by the space of the loft. The methods used in developing shell plate apply equally to stringers, longitudinals, stern plating, etc.

By the use of stiff but flexible battens along the top and bottom edges, fastened by a nail to the floor at each intersection, the operation of developing a plate on the floor is not as difficult as one would surmise by its appearance, as shown in the figure.

A table of distances for the triangles can be figured out previously for the projection expected by observing the minimum and maximum projections on the body plan. Indeed, it is possible that from this table a set of figures can be obtained for each individual plate and can be placed on the shell expansion plan or sent out to the layer out in tabulated form; this information to give the true outline of the plate and measurements of any longitudinal or stringer crossing thereon. The layerout, with this information at hand, can then place it direct on the material, thereby dispensing with such extensive mold-making and material. There would be necessary only a loose-butt

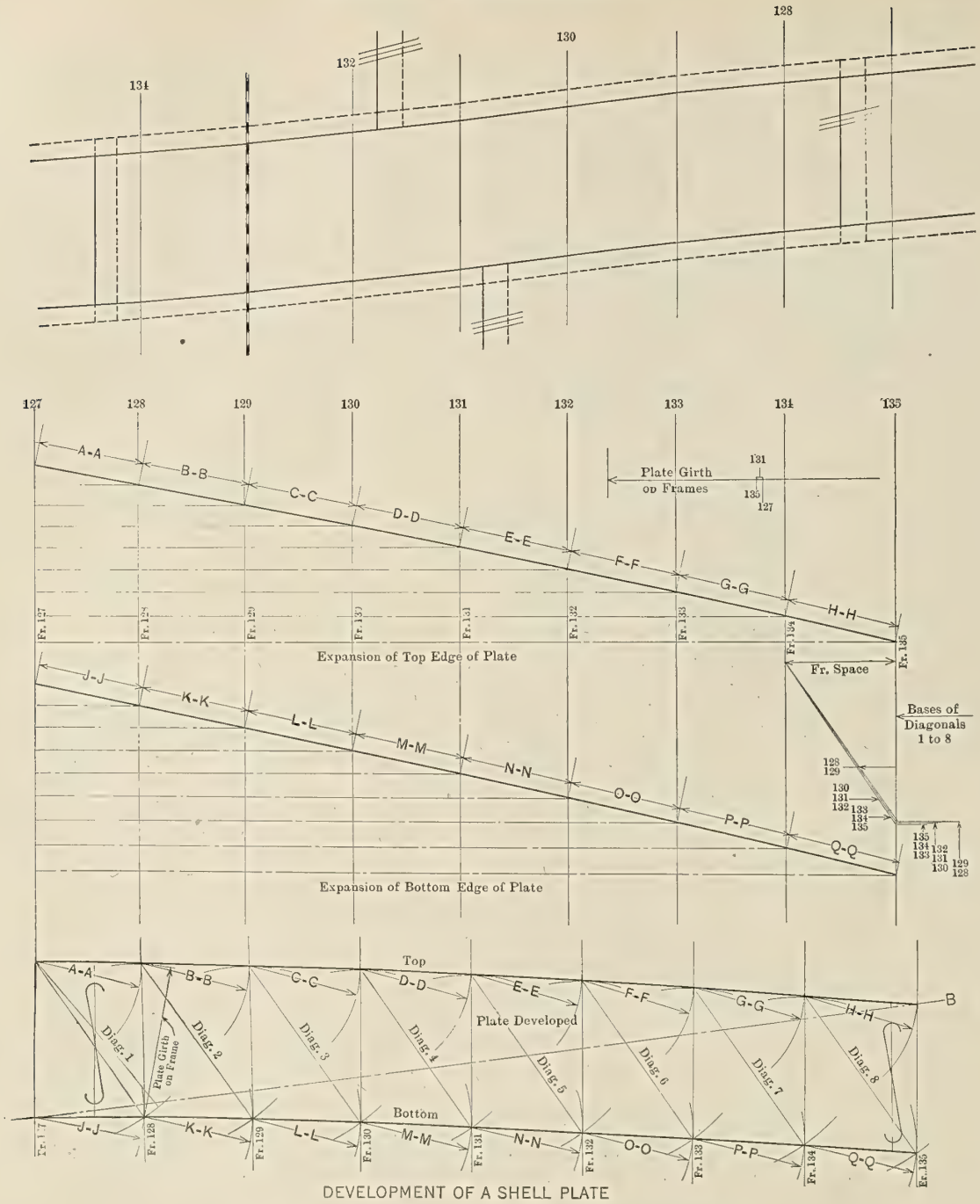


Fig. 5.—Shell Plate Developed by Triangulation Method

mold, lap-edge mold to be applied at every frame space, a frame mold and frame-space longitudinal mold.

Certain yards develop the inside strake of shell plating only in the mold loft and depend on this strake as a rib-band and guide to pull the structure together properly, and then any inaccuracies or defects that may develop are overcome by templating the outside strake from the ship. To a yard that follows the above custom, this direct method would be economical as well as providing a more equal distribution of work, besides the important feature of laying off but one plate, the mate or mates thereto being duplicated from the original plate after punching. If there may be more than one hull, the advantage in multiplicity is at once obvious. The cost of the handling of the original plate as a template is nil, especially as the duplication can be performed by unskilled labor.

Lifting Bevels

The frame bevels are lifted in the loft by a bevel stick made of white pine and shellacked. The method of making one is shown in Fig. 6. By applying this stick on the body plan and measuring the distance between any two frames the bevel is immediately ascertained in degrees. The number of degrees of bevel is stamped on the mold at that particular point for the frame bender's information.

Angle bars are assumed to be zero at 90 degrees, and are opened or closed, as shown in Fig. 8. In measuring the degrees for flanging plates, the plate is considered zero when in a flat state and is measured thus, as illustrated in Fig. 7.

Curved Frames' Lines on Shell Plates

Forward and aft, that is, after leaving the parallel middle body or dead flat section adjacent to the bilge and forward in the flam of the bow, the frame lines develop not as straight lines but as curves. This can be readily seen from the following: Assume the ship's surface as a sec-

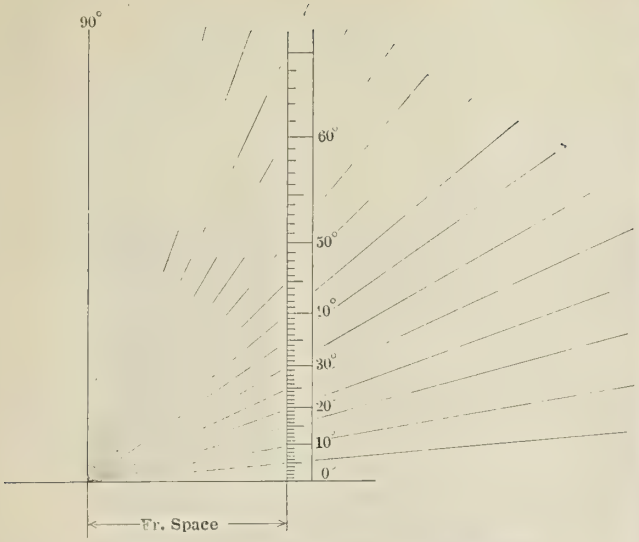


Fig. 6.—Method of Making a Bevel Stick

tion of a cylinder, the developed line of a plane cutting this cylinder normal to the axis of the cylinder will, of course, naturally develop as a straight line. But forward and aft the plane of the frames is not normal to the axis of a cylinder, consequently the frame line will not develop as a straight line.

In Fig. 9 is shown a frame exaggerated as to curvature, to make it more pronounced at a section where the frame is not normal to the shell surface. The figure to

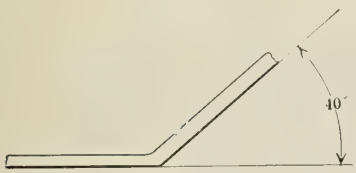


Fig. 7

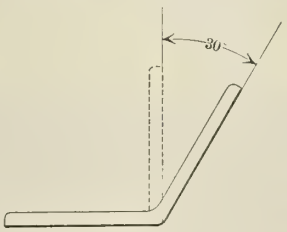


Fig. 8

the right shows the plan view of this section with the plate edges at Z at top and Z at bottom and assuming a water-line or datum line at X. The frame $Z\ X\ Z$ is not normal to the shell surface, the normal plane being $Z\ A$, which will develop as a straight line. The frame line $Z\ X\ Z$, however, will develop as a curve. The distance $X\ A$ is

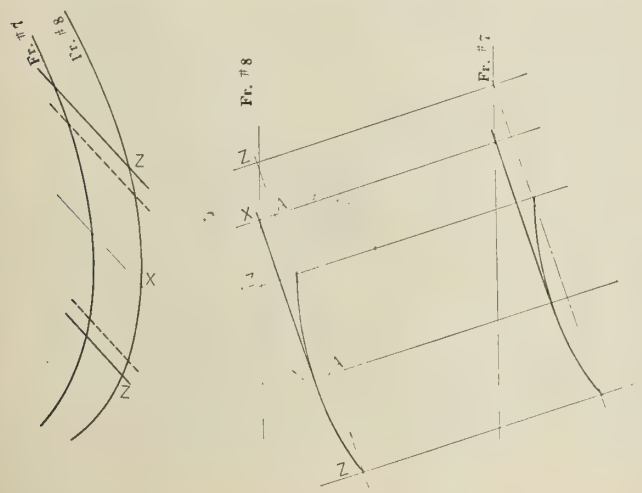


Fig. 9

Fig. 10.—Bevel Blocks in Position for Lifting Shell Flanges

therefore the difference between the normal plane and the actual plane of frame. It is then simple to place the distance $Z\ A$ on the template and springing a batten through the three points $Z\ A\ Z$. This repeated at each frame will give the desired curvature.

This method is much simpler and entails far less labor than the method shown in Fig. 10, which is self-explanatory.

Errata.—In the article on "Straight-Lined Model Experiments," page 341, August issue, the tabulated data in the upper right hand corner of Fig. 3, at the top of the page, are in error in that the letters E and D in the first column have unfortunately been transposed, making the fuller vessel appear to be the more easily driven, which, of course, is contrary to fact. The data in the upper line of this table refer to type D ship, while the figures in the lower line apply to type E ship.

In Fig. 4 on the following page the lower curves marked E. H. P. should be marked F. H. P., as they represent the frictional horsepower. The other curves in the figure represent the total E. H. P.

In the article on "Reinforced Concrete for Shipbuilding," page 303, July issue, Table I, at the top of the page, is in error with respect to the following items, which should read as follows:

	Reinforced Concrete	Steel
Interest on repair cost at 5 percent	$ 750.00	$ 1,154.00
Total cost	25,152.00	44,549.00
Annual cost	718.63	1,781.96

Port and Terminal Efficiency.—Advancement of port and terminal efficiency will be discussed at the annual convention of the American Association of Port Authorities, to be held at Cleveland, Ohio, September 11 to September 14. Special consideration will be given to legislation requiring common carriers and steamship lines to use their terminal facilities in such joint manner as will promote the utmost efficiency in the handling of all commodities.

MOTORSHIP S. I. ALLARD

Designed and Built by St. Helens Shipbuilding Company, St. Helens, Ore.

Fig. 1.—Engine Room Looking Aft, Port Side. Auxiliary Unit at Right

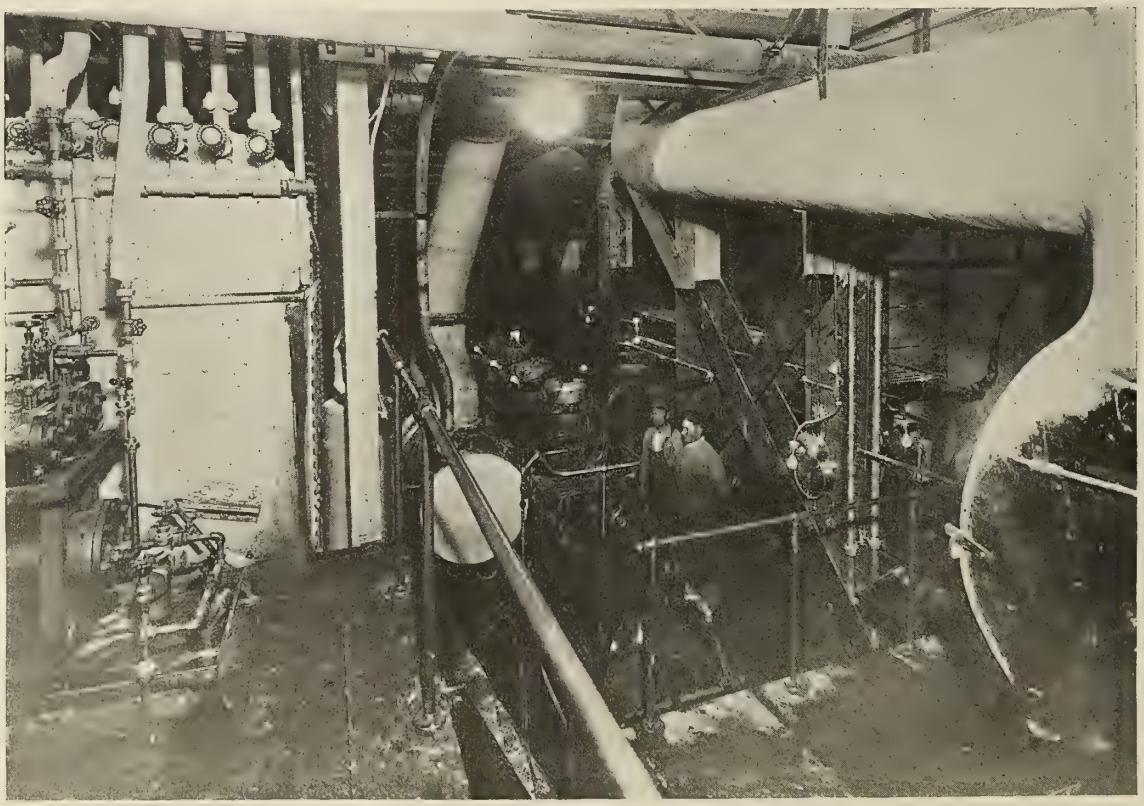


Fig. 2.—Engine Room, Looking Aft, Starboard Side. Donkey Boiler at Right

Fig. 3.—Motorship *S. I. Allard*

Maiden Voyage of Motorship S. I. Allard

THE wooden motorship *S. I. Allard,* designed and constructed by the St. Helens Shipbuilding Company, St. Helens, Ore., for Charles R. McCormick & Co., San Francisco, Cal., recently completed her maiden voyage to Sydney, Australia, after being twenty-six days out from Honolulu. The run from the Columbia River to Honolulu was made in thirteen days. At Honolulu the vessel stopped for spare machinery parts and equipment which had arrived in San Francisco too late to be placed aboard the vessel before sailing. The total sailing time of the vessel from the Columbia River to Sydney, Australia, was thirty-nine days, which is considered an exceptionally good performance and indicates that the auxiliary

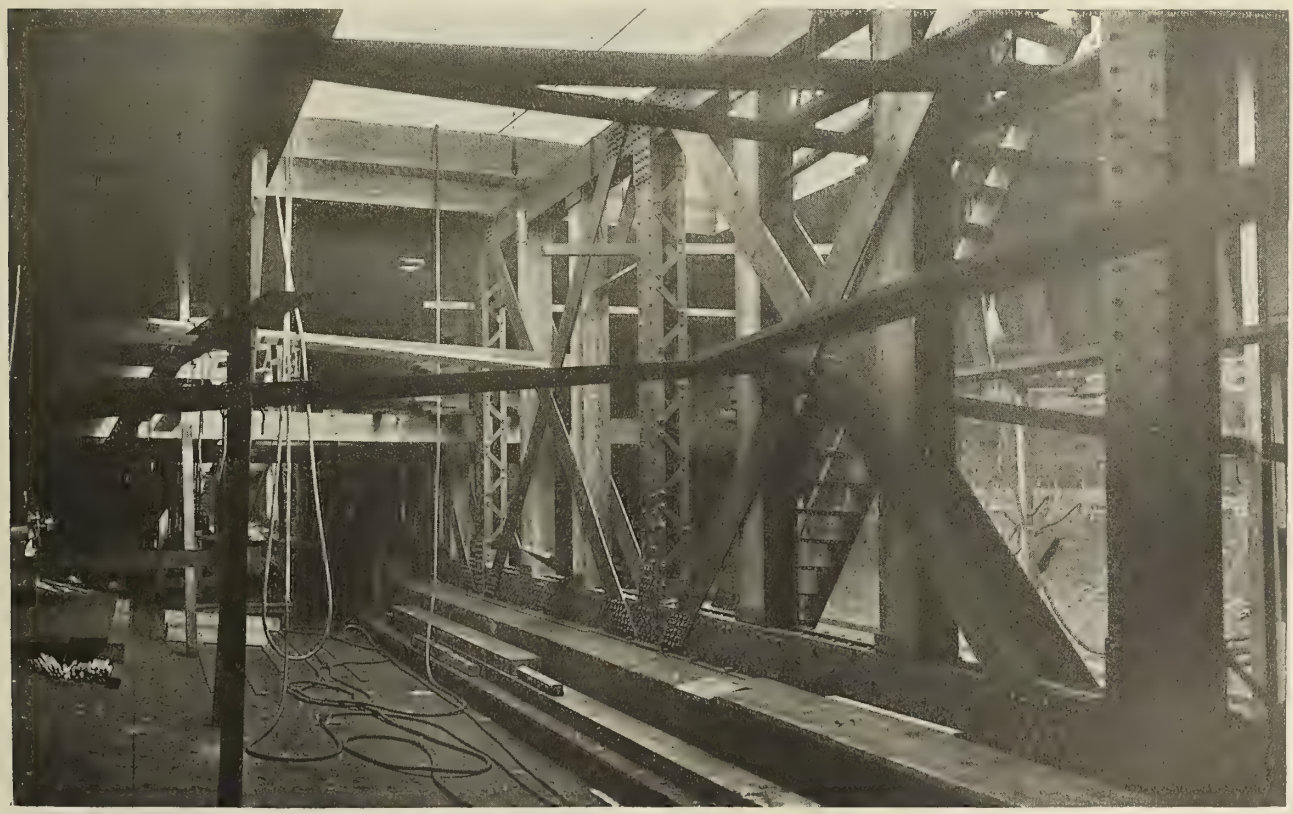


Fig. 4.—View of Hold, Showing Centerline Steel Truss

schooner type of motorship will prove a strong competitor for overseas transportation.

Charles R. McCormick & Co., owners of the vessel, are pioneers in the development of this type of motorship. The *Allard* is a duplicate of the motorship *City of Portland,* which has already carried two cargoes of Douglas fir lumber to Australia, and also of the motorship *City of St. Helens,* recently launched by the St. Helens Shipbuilding Company for the same owners.

The *S. I. Allard* is 278 feet long overall, 246 feet 5 inches long between perpendiculars, 47 feet 3 inches beam molded, and 21 feet 11 inches depth molded. On her maiden voyage she carried 2,000,000 board feet of Douglas fir with a mean draft of 22 feet 6 inches. She has a tankage capacity for 1,660 barrels of fuel oil (20 degrees Baumé gravity), and on an average consumption of one barrel of fuel oil per hour under full power is capable of making any port in the world.

The vessel is four-masted, baldheaded, schooner rigged. Her sister ship, the *City of Portland,* has five masts, but in the *Allard* the fifth mast was discarded and in place of it a funnel was installed for the discharge of the exhaust gases from the auxiliary engines.

In addition to her sail power, the vessel is propelled by two sets of 320 brake horsepower Bolinder hot hulb internal combustion engines driving twin screws which give her an average speed under engine power alone of 8 knots and from 13 to 14 knots under engine and sail power in a fairly stiff breeze.

For handling cargo, she is equipped with four 8-inch by 8-inch vertical steam winches of the Pacific type, an 8-inch by 8-inch steam anchor windlass and a 5-inch by 7-inch steam capstan, all of which are operated by a 66-inch diameter dry back horizontal donkey boiler, carrying 130 pounds of steam, located in the engine room. For operating the auxiliaries at sea, compressed air at 150 pounds pressure is used, the air being taken from the compressors of the main engines. For this reason it is unnecessary to carry steam on the donkey boiler at sea. The auxiliaries also include two electric generator sets of 5 and 7½ kilowatts capacity respectively, and an electric steering gear of the Hewitt type.

The machinery installations on the *Allard* and her sister ships have been under the personal supervision of Mr. W. R. Hewitt, consulting engineer for Charles R. McCormick & Co., and he has watched closely the operation of these engines from the time of the construction and first trip of the *City of Portland* to date, making such changes and improvements as experience has shown to be desirable. On her trial trip, held over a measured mile course in San Francisco Bay on April 26, the average speed of the *S. I. Allard* for a period of five hours was 9.63 miles per hour.

Salvaging the Submarine H-3

Stranded Vessel Lifted Out of Quicksand and Hauled Over a Mile Across Country on the California Coast

DURING a heavy fog, on December 14, 1916, the United States submarine H-3 went ashore on Samoa beach, near Eureka, in Humboldt County, California. On December 28 bids were opened by the United States Government for salvaging the vessel either by putting her afloat in the ocean or hauling her from her position on the beach across the sand pits separating the vessel from Humboldt Bay, a distance of about one mile, and launching her in Humboldt Bay.

Six bids, ranging from $18,000 (£3,700) to $72,000 (£14,800) were submitted for the latter operation. The lowest bid, however, which was submitted by the Mercer-Fraser Company, of Eureka, Cal., was so much lower than the others that the Government was skeptical about the contractors' ability to carry out this work, and therefore decided to attempt to salvage the vessel themselves by towing her to sea.

For this purpose, the United States cruiser *Milwaukee,* the monitor *Cheyenne* and the naval tug *Iroquois* were sent to Eureka. Two steel cables 2 inches in diameter and 4,000 feet long were attached to the submarine and to the stern of the *Milwaukee.* During a heavy fog on the night of January 13, after the *Milwaukee* had been pulling on the lines for about two days, the *Milwaukee* drifted into

Fig. 1.—Timber Crib Work Over Submarine

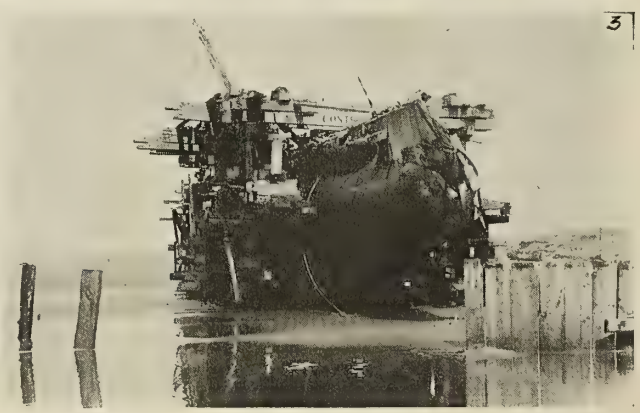


Fig. 2.—Submarine Lifted from Quicksand

the breakers, due to the weight of the cables and the strong current. At the time of this mishap the tug *Iroquois* was connected to the bow of the *Milwaukee* with a long towline, which parted, and before another line could be attached the *Milwaukee* hit the bottom and within a few hours she was well into the breakers, finally becoming a total wreck.

On January 23 the Government again opened negotiations with the Mercer-Fraser Company, and on January 26 signed a contract with this company for salvaging the submarine at their original bid. Between the time that bids were originally opened and the signing of the contract the submarine had shifted north on the beach about 300 feet, and had settled into the sand about 6 feet deeper, which made the salvaging work much more difficult. At low tide the water rested for a distance of about 75 feet outside of the boat, and at high tide it came up on the beach about 250 feet inside the boat. Figs. 1 and 3 show how deeply the submarine had settled in the sand.

The first operation carried out by the contractors was to place seven steel cables, each 2 inches in diameter, around the submarine, for the purpose of lifting her out of the sand. Placing these cables under the vessel was not only the most difficult part of the work, but it was the feature which made the task seem to others almost impossible. Owing to the fact that the beach was of quicksand formation, it was impossible to excavate around or under the boat, or to pump the water out of such excavation, because this would only tend to cause the submarine to sink deeper into the sand.

The manner in which this difficulty was overcome shows the resourcefulness and ingenuity of the contractors. A force pump was set up on the beach and two lines of 2-inch hose attached to it. To the end of this hose two long joints of pipe were attached, and on the end of the pipe a small cable was attached. The pipe was placed in position where it was desired to place the cable, and at such an angle that when the pump was started and water turned into the pipe, the pipe would work down into the sand so that the end of the pipe with the cable attached to it would come just under the keel. Water was then run slowly through this and a pipe was jetted down from the opposite side of the submarine at such an angle that the end of it would intersect with the end of the other pipe to which the cable was attached. This made a hole in the sand large enough to admit a ¾-inch rod hooked at the end. By fishing with this the end of the small cable was hooked and pulled through under the submarine. It

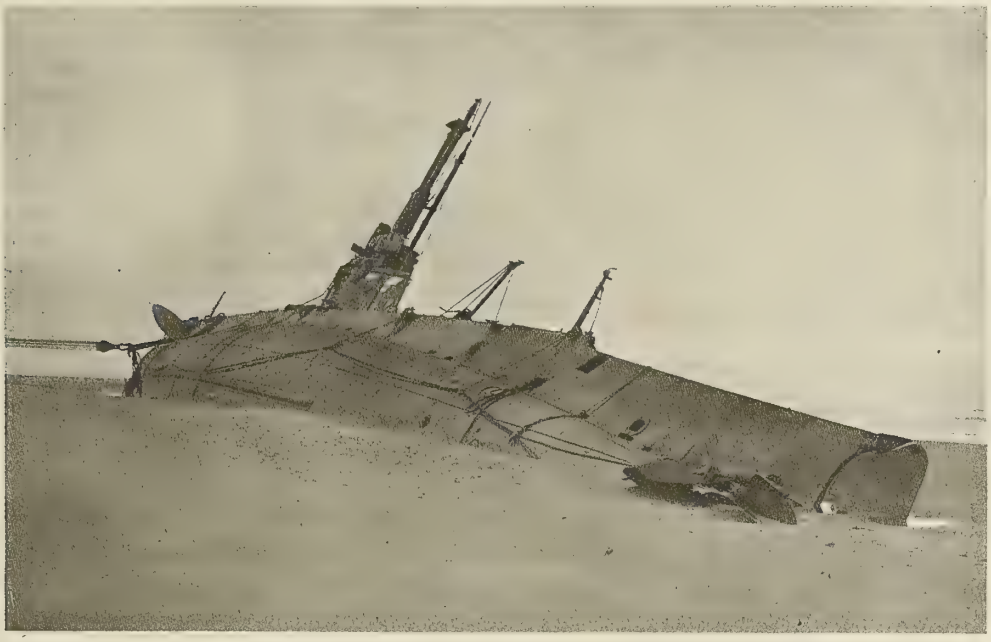


Fig. 3.—Position of the Submarine When First Embedded in the Sand

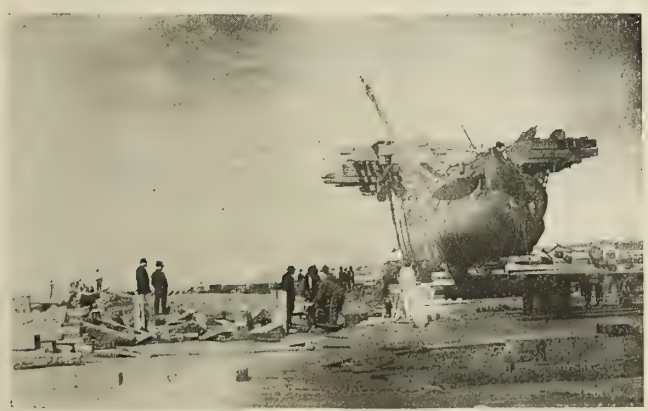


Fig. 4.—Vessel Moved on Rollers 150 Feet Up the Beach

Fig. 5.—Arrangement for Transporting Submarine to Humbolt Bay

then became a simple matter to pull the 2-inch lifting cables around the submarine in the desired positions.

After the cables were in place a timber crib work was built, as shown in Fig. 1, to provide a means for lifting the submarine with screw jacks. The cross timbers were built up in units of four. Each timber was 12 inches by 12 inches in section and was of sufficient length to extend over the full width of the boat. Fourteen Norton ratchet screw jacks, with a capacity of 50 tons each, were used, and as the boat was estimated to weigh over 400 tons a good margin of safety was provided in the necessary lifting power and also in the strength of the lifting cables, as each of the seven cables had a breaking strength of 140 tons. Fig. 2 shows the arrangement of the cribbing, etc., when the submarine was raised from the sand and ready to be hauled up on to the beach. The foundations for the jacks were placed on piling driven on each side of the ship.

Critical Point of the Salvage Work

The critical point of the salvaging operations occurred at the time when the submarine was lowered on to rollers for hauling her up sideways on to the beach. While this operation was being carried out, the submarine was exposed to the tide, and, as the tide remained down only two and a half hours, any delay in the operations would have made it impossible to protect the submarine and she would have again settled down into the sand. This operation was carried out without a hitch, however, and Fig. 4 shows a view of the submarine after she had been moved about 150 feet up the beach.

After the vessel was above the high water mark on the beach the timbers were removed, as shown in Fig. 5, and a pine log, 80 feet long and 40 inches diameter at the small end, was placed on each side of the boat. Cables were placed around these logs and under them at each end were placed bobbers made up of four pieces of 14-inch by 14-inch timbers 20 feet long, solidly bolted together. As can be seen from Fig. 5 all the weight coming on these bobbers was carried at the center, permitting them to equalize when the grade was changed. The bottom of the timbers were shod with maple.

The Mile Journey Overland to Humboldt Bay

For moving the submarine across the sand pits a distance of a little over a mile to Humboldt Bay, a track consisting of three pieces of 6-inch by 16-inch pine was laid and the submarine was moved on rollers, each 4 feet long and 8 inches diameter, of California laurel, spaced 4 inches apart under the bobbers. Power was furnished by a hoisting engine operating through a pair of five-sheave blocks. As no attempt was made to grade the sand hills down to a perfect level, the vessel was moved with this tackle over grades as high as 4 percent. The submarine moved on an average of about 550 feet per day, the longest distance covered in one day being 1,060, while on another day 930 feet was covered.

On April 20 the submarine was launched in Humboldt Bay, the job having cost a little less than was originally estimated, therefore giving the contractors a good margin of profit.

This remarkable salvaging work was planned by Mr. James D. Fraser, president of the Mercer-Fraser Company, and carried out under his personal supervision.

Italy Building Standard Ships.—The Italian dockyards are constructing steamships of a uniform type of about 8,000 tons deadweight carrying capacity, the first of which has recently been completed.

Improving Purchasing Methods

BY H. B. TWYFORD

One of the most important economic problems of the business world is that of bringing into closer relationship and forming better connections between buyer and seller. Practically every manufacturing establishment and every concern with a commodity to sell has a very much larger percentage of wasted effort in placing its product on the market than it would have if better buying methods prevailed.

While great improvements have been effected in recent years in purchasing systems, and many departments are operated at a very high degree of efficiency, nevertheless conditions surrounding the work are far from ideal and the particular features of it, which have such a large influence on the economic operation of business, are too often neglected or receive insufficient attention. This is particularly noticeable in connection with two features of a purchasing agent's activities. One of these is the frequency with which incomplete or incorrect specifications and descriptions are allowed to pass through his office and be issued to those concerns from whom he asks for quotations, prices and information, and the other is the loose manner in which the firms are selected who are invited to cater for his business.

Accuracy in Specifying and Defining Goods

The requisitions which are sent to the purchasing agent are his authorizations to buy and form the basis and groundwork for all purchasing operations. It is necessary, therefore, to start with these in good order. If they are not so, as is often the case, they must be beaten into proper shape when they first arrive in the department.

Generally speaking, purchasing agents are commercially rather than technically trained, and all those requisitions for material which require specifying in detailed technical terms should be accompanied by proper specifications furnished by the engineering department. If the use of this material has been definitely determined and established, the purchasing department should keep on hand a sufficient number of copies of the specifications to enable it to make purchases without delay. The closing of a large contract by the sales department may make it necessary to buy certain materials quickly, and in such cases the purchasing department should be in a position to act promptly and not be dependent on some other department to furnish specifications with the usual attendant delay.

Specifications can be divided into two classes, those described in the last paragraph and those which are covered by well-recognized trade customs and usages. The latter embraces a large variety of materials and innumerable small articles, and it is in connection with these that most of the trouble occurs. Different names are used for the same articles; methods of specifying dimensions vary considerably and the description of quality, style or finish is frequently given in a variety of ways by persons in the different departments of the same establishment.

There is no good reason why this should be so, and to overcome the trouble some firms have adopted standard definitions for everything they use. These standard definitions are printed in some convenient form and distributed to all interested parties for reference purposes. These are excellent, but they are purely reference data and, like all similar data, are not always referred to when in doubt or are neglected because a man thinks he is sure of the proper definition, whereas quite often he is at fault.

But although the adoption of standard articles may be secured, *standard methods of describing them are not.*

The responsibility, therefore, devolves upon the purchasing department, and it is in an excellent position to handle the matter, as it is in constant touch with manufacturers and is better posted and acquainted with the recognized trade descriptions and methods.

The manner in which this can be done is by the use of purchase order record forms. It is good practice to refer all requisitions as they come into the department to the clerk who keeps this record. He is then able to note on requisition where the material was last bought, the price paid, time required for delivery, and can at the same time *check the specification.* There are several other forms which could be used for the purpose indicated, such as the price records, record of sources of supply, or the stores inventory, and the selection of one of these can be governed by the methods which may be in use in handling the purchasing work.

Except for some miscellaneous items a separate sheet should be used for each article purchased and the standard definitions can be printed or written thereon. With the checking of the requisitions against these when they first arrive in the department an infallible method is enforced which absolutely prevents improper, incomplete or inaccurate definitions being issued with requests for prices or with orders.

In specifying and defining these small articles and certain regular commercial material, the manufacturer's standard practice should be adopted wherever possible, with such modifications as individual circumstances require. The descriptions should always be as concise as possible. In many cases two or three words or figures may suffice. The article should be clearly described beyond danger of misconception in the fewest possible words. An unnecessary word will often create an element of doubt and frequently the omission of one will mean that the description could be used to cover several grades or varieties.

Getting the Right Competition and Selecting Sources of Supply

The other feature of purchasing alluded to in the first part of this article is in connection with the selection of those firms with whom a purchasing agent negotiates for prices and places orders. This is of equal importance, or even greater than the question of proper specifications and definitions. It certainly offers a wider field for the purchasing agent's imagination and resources, and his authority should be supreme in everything pertaining to this phase of buying.

There are no limitations to the purchasing agent's market, providing he can get the right price and delivery. These two conditions are often governed by geographical considerations, but during the recent strenuous times many buyers have had to go to entirely new markets to secure their requirements. To get the right price there must be the right kind of competition—that is, competition between those firms who are in the best position to supply the goods required. This point is too often ignored and many buyers think that, because they secure a number of quotations for comparative purposes, that is sufficient to insure sound competition. Nothing could be more fallacious, for it is only by a very careful selection of the right firms that the desired results can be obtained. If requests for quotations are sent out in a haphazard manner it is doubtful whether one gets in touch with the people best fitted to supply the material.

Illustrations of this occur daily because sufficient care is not exercised by buyers in selecting their sources of supply. Take a list of concerns handling such commodities as steel, lumber, chemicals, leather, etc., and it will be found that certain of them are in much better position to supply a certain grade than others. This applies also to all kinds of manufactured articles. Take, for instance, bolt and nut manufacturers; some of them make only machine bolts and cold punched nuts, others make finished bolts and milled nuts. Some confine themselves to large sizes and others to small.

These distinctions and refinements are the result of the universal tendency to specialize, which really means more intensive manufacturing and merchandizing. If a purchasing agent goes into the market in a general way and on a hit-or-miss principle he may strike the firm who can best serve him or he may not. There should, however, be no doubt on this point, for, as pointed out in the first part of this article, far-reaching consequences are involved.

A form should be used for collecting and tabulating information regarding sources of supply. Having proof that a firm makes or can supply the exact material he needs, it is then incumbent on the buyer to investigate other features, such as its capacity and output, the location of its factory or shipping point, its method of doing business, reliability, etc. With all of these features favorably determined a purchasing agent can approach all such firms he may have listed with the positive assurance that any quotations he receives will represent sound and reliable competition, and he will know that the orders he places will have proper attention.

This will have been accomplished with the least loss of energy to his own department, the least disturbance to the commercial world and at the least expense to all competitors for his business. These are important economic considerations.

By trading only with those firms who are best equipped to supply him, a purchasing agent not only secures for himself protection against high prices, but the efficiency of his department is greatly enhanced. There will be less follow-up work in getting shipments made at the desired times. Invoices will be rendered promptly, insuring all cash discounts being available. Complaints regarding material will be greatly lessened if not entirely eliminated. Useless and superfluous correspondence on all these points which so frequently encumbers a purchasing department will be avoided.

The information and data necessary in compiling the list of sources of supply can be accumulated from many avenues. There is first one's experiences in the negotiations and transactions taking place daily in the office. A careful survey of the advertising columns of trade papers and periodicals will add many useful names. There are the trade registers and classified directories. In taking names from any of these sources the important point to keep in view is how they fit in with one's own objects. More information than is usually obtained from an advertisement or directory must be secured before they can be deemed eligible for the special lists kept in a purchasing department.

The two points which have been emphasized in this article may be designated as the two main fundamentals of purchasing. The seller has no means of protecting himself from buyers who request prices and information on goods which are ambiguously or incompletely specified, or for goods which he cannot furnish, or is not best fitted to supply. The buyers themselves can improve these conditions and will reap any resulting benefits.

Further Experiments Upon Wake and Thrust Deduction*

Effect of Variation of Block Coefficient of Model—Variations in Relation to Prismatic Coefficients of After-Body

BY W. J. LUKE

IT has been the pleasing duty of the writer to present to the Institution two papers on this subject, one in 1910,† followed by another in 1914.‡ The first of these contributions dealt with the results of experiments on one particular model, chosen so as to represent, as nearly as could be judged, a mean of current practice; the principal feature of that paper was the section dealing with the variations in value of the hull efficiency elements due to variations in angle bossing. It may be recalled that with twin outward turning screws the adoption of horizontal bossing led to large wake fractions, and that considerable diminution of these wakes resulted from sloping the bossing; the reverse result was reached with inward turning screws. The effect of these variations on the thrust deduction fraction was much less marked. Other results were reported, but were of a distinctly less novel character. The contribution made in 1914 extended these results to the cases of quadruple screws, and also gave results to experiments with screws centrally placed.

It was quite evident that much ground remained to be covered by experiment; for example, changes in proportion of the ship's dimensions might have a perceptible effect on the values of the factors under discussion, but it seemed from the examination of a number of isolated examples that no great variations would probably be found to result. It was known that this was not the case with variations in fullness of form, consequently the present notes have been compiled as complementary to the previous contributions and may perhaps be looked upon as finishing the present writer's contribution to this subject.

As it was expected that the variations in wake values would be tolerably regular, the experiments were first planned for two models, one with a block coefficient of 0.55, and the other of 0.75. They were of the same linear dimensions as the model of 1910, viz:

Length	204
Beam	30
Draft	9

This seemed to promise with that model such a series as would—with a little extrapolation—cover all usual cases. There appeared to be no necessity to multiply experiment, nothing was done with inward turning screws, and it was at first intended to make no variations in propeller dimensions. The 6-inch propellers of the original experiments were made use of, placed just as before, viz.: with a spread between their axes of 10 inches with their centers 1½ inches before the after perpendicular, and with 2-inch immersion. Bossings were fitted at four different angles of inclination, viz.: at 0 degrees, 22½ degrees, 45 degrees and 67½ degrees from the horizontal, and were uniformly ¾ inch thick, rounded on the outer edge and well tapered abaft. In all these details it will be seen that the original data have been entirely followed.

No records of rotative efficiency were taken, as the actual screw efficiency has no especial bearing on these investigations.

$$\text{Standard speeds of } \frac{V}{\sqrt{L}} = 1.00 \text{ and } \frac{V}{\sqrt{L}} = 0.66$$

were adopted for the two models respectively. The curves shown in Fig. 1 represent the results of the experiments

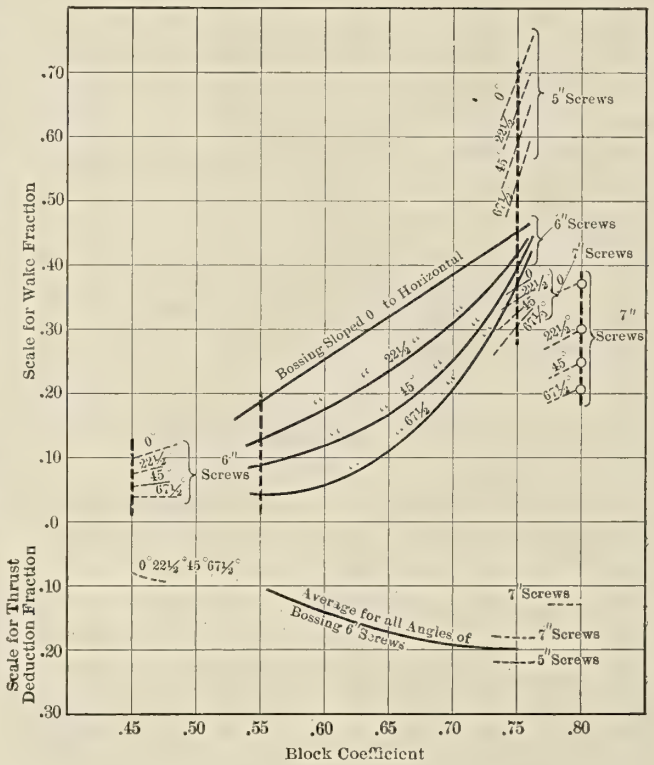


Fig. 1

associated with those previously presented for the model of 0.65 block coefficient, and show that while the results of the finer of the two new models were just about what might have been expected, those for the fuller model were higher than looked for, and showed very moderate variations, due to variations in angle of bossing; in this latter case the experiments were repeated in their entirety and their substantial accuracy was confirmed.

As previous experiments had led to the expectation that the plot of wake values on a basis of fullness would have assumed an approximately rectilinear form, the result was nothing short of disappointing. However, after considering a number of possible reasons for this result, it was at last concluded that although not much influence might have been exerted by the selected relations of length to transverse dimensions, yet for a model of the fullness adopted the relation of width to depth was abnormal, and as a partial result of this the screw was on the small side. Sets of experiments with screws of 5 inches and 7 inches

* Paper read at the Institution of Naval Architects, March 29, 1917.
† Trans. I.N.A., Vol. lii, page 43.
‡ Ibid., Vol. lvi, page 33.

in diameter were made and thoroughly confirmed this latter conclusion.

To complete, it was therefore decided to make experiments on another model with a proportion of draft to breadth of 0.475 and with 7.5 beams in the length.

The departure from the previous $\frac{\text{Length}}{\text{Breadth}}$ proportion

was made somewhat reluctantly, but upon consideration that the results would probably be but little affected thereby, and as there was a pressing reason for time economy when the experiments were made, this variation from precedent was accepted.

The draft of the new full model thus became 12.9 inches; and in the experiments screws of 7-inch diameter were adopted, with a tip immersion of 4 inches. The results of these experiments were fairly harmonious with preconceived ideas; and serve to show (with full ships at least) what wide variations may result from unsuspected causes.

Opportunity also offered to run a few experiments with a model of as low a block coefficient as 0.45; here, again, the proportions are not quite those adopted as standard. The speed adopted was

$$\frac{V}{\sqrt{L}} = 1.33,$$

and the results are shown for comparison.

It is of great importance here to note that these values will not apply to vessels of excessively high speed in relation to size; although as regards fullness of form they come within the range dealt with in this communication. Torpedo-boat destroyers and other light craft, whose speeds are pushed up to values of

$$\frac{V}{\sqrt{L}} = 2$$

and beyond, seem to have reached an order of circumstance different in character. Taylor has pointed out that increase in fullness for the same length and displacement gives rise to diminution in resistance, and analysis at least shows that the wake has a negative value. It must, therefore, be carefully borne in mind that the results here presented are not applicable to vessels of this type.

So far, only wake has been mentioned, as it is that factor of the hull efficiency which seems to be subject to the greatest amount of variation. It will suffice to note merely that the thrust deduction values are exhibited in the companion curve, and really call for no special remark.

It may be asked, What is the purpose of all this investigation? The answer is, that it is essential to assess fairly the elements of a propeller in the stage of design, and is by no means for the purpose of showing where a propeller is to be placed so as to get the "maximum return from the wake current." For the purpose of making this clear, it will be well to repeat a paragraph from the communication of 1910. The method of experiment and the subject of experiment were thus described:

"It may be imagined that a traveling carriage can be made to run over a body of water, and at a speed that can be diagrammatically represented by $A\ B$.

"Imagine next that this carriage carries a screw propeller made to revolve at such revolutions that if working without slip its speed of advance would be $A\ C$. Then $B\ C$ is the slip, and

$$\frac{B\ C}{A\ C}$$

the slip as ordinarily expressed as a fraction of the propeller speed, or as a percentage by being increased a hundredfold. The conditions under which such a propeller is working are described by the word 'open,' and are not the same as those in which a propeller works when propelling a ship.

"The ship in its onward path is followed by a belt of water of complex motion, and if (over the propeller disk) it can be assumed that its average forward velocity is $D\ B$, the propeller is carried along at the former speed over the ground, and, being revolved as before, would behave in some respects as would an 'open' propeller advancing with a speed $A\ D$ and with a slip $D\ C$.

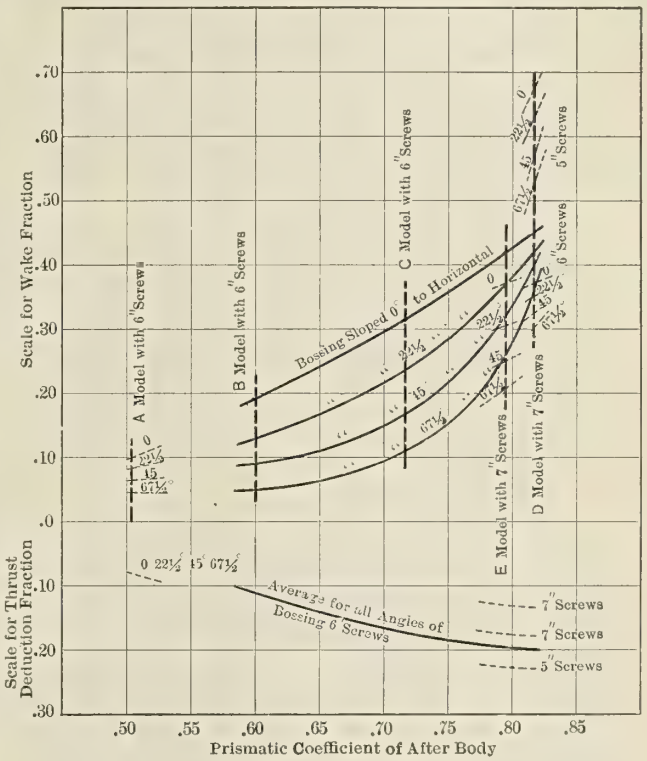


Fig. 2

"The wake velocity, as before stated, is $D\ B$.

"The wake fraction w is

$$\frac{D\ B}{A\ D},$$

as in Froude's original nomenclature.

"The apparent slip is $B\ C$, and the apparent slip ratio

$$\frac{B\ C}{A\ C}.$$

"The real slip is D C, and the real slip ratio

$$\frac{D\ C}{A\ C}.$$

"The thrust is appropriate to the speed of advance $A\ D$ and a slip $D\ C$.

"The thrust, however, is being overcome at a velocity $A\ B$, and the apparent work is thrust $\times\ A\ B$, instead of, as with an 'open' screw, thrust $\times\ A\ D$, and under such circumstances the work 'behind' shows an excess over that obtained in the 'open' in the ratio

$$\frac{A\ B}{A\ D},$$

the excess over unity being the 'wake gain.'"

So that the factor in the hull efficiency which denotes

"wake gain" has already been exactly allowed for in a corresponding deduction in the suppositious speed by which the thrust advances. There is, in fact, no such wake gain, though the idea recurs from time to time.

It was pointed out by Mr. Baker* that wakes might be more satisfactorily dealt with by considering their variations in relation to the prismatic coefficients of the after-body. Fig. 2 shows the results plotted on this base. It is certainly more regular in form than the graph on a base of block coefficient of the whole form, and consequently it might be well, in accumulating data, to follow this line. It calls for no further remark in this connection.

A most important use to which the sum total of the information available on this subject can be put is in its application to the results of trials. A trial carefully conducted results in records being obtained of horsepower, speed and revolutions of propellers;

TABLE I—WAKE AND THRUST DEDUCTION

Particulars of Models

Model	δ	M	B	D	ϕf	ϕa	β
A	0.45	7.25	0.967	0.319	0.542	0.504	0.860
B	0.55	6.45	0.968	0.290	0.540	0.600	0.965
C	0.65	6.20	0.910	0.275	0.627	0.719	0.965
D	0.75	5.82	0.873	0.262	0.734	0.820	0.965
E	0.80	5.29	0.705	0.335	0.820	0.796	0.990

Where δ = block coefficient,
ϕf = prismatic coefficient—fore body,
ϕa = prismatic coefficient—aft body,
β = mid area coefficient,

$$M = \frac{L}{\Delta^{1/3}} \times 0.3057, \text{ or } \frac{\text{length}}{U}.$$

$$B = \frac{\text{breadth}}{U},$$

$$D = \frac{\text{draft}}{U}.$$

TABLE II—WAKE AND THRUST DEDUCTION

Comparison of Wake Values Obtained by Analysis from Taylor's 1904 (Three-Bladed) Propeller Curves and Those Obtained from Fig. 3

Case	δ	Angle of Bossing	Trial Analysis Wake	From Wake Curves
		degrees		
Twin-screw cargo ship....	0.725	25	0.29	0.28
" yacht	0.532	30	0.09	0.14
" cross-Channel steamer	0.481	38	0.10	0.09
" cruiser	0.518	—	0.12	0.12
" cross-Channel steamer	0.498	15	0.16	0.14
" cruiser	0.521	—	0.10	0.12
" liner	0.710	14	0.32	0.30
" cruiser	0.534	—	0.14	0.13
" cruiser	0.510	—	0.07	0.11
" cross-Channel steamer	0.500	20	0.12	0.13

and probably also some idea of the efficiency of the result achieved; at least whether the result is good, indifferent, or disappointing, even if the resistance of the ship, as derived from model experiments, is not known. These data furnish the only records from the ship and machinery from which an estimate of the various causes contributing to the efficiency of the whole installation can be assessed. One very important feature is the efficiency of the propeller, which in turn is largely bound up with the slip at which it is working; and before the real slip as distinct from apparent slip can be determined, some approximation to the wake must be made.

There is no doubt that when any large collection of data has been got together it must be carefully analyzed in order that the information contained in it can be made generally avalable; failing this, departure in a design from some previous example in any material degree can be nothing more than a leap in the dark.

For the purpose of the analysis here mentioned some scheme of model propeller experimental results is also necessary, and there exists a choice of four or five different sets. These all differ from each other, not fundamentally, it is true, but sufficiently so to suggest that, wherever practicable, one and only one set of curves should be used when a number of different results are being analyzed. With them it may also be found that the absolute figures for wake and thrust deduction may not hold

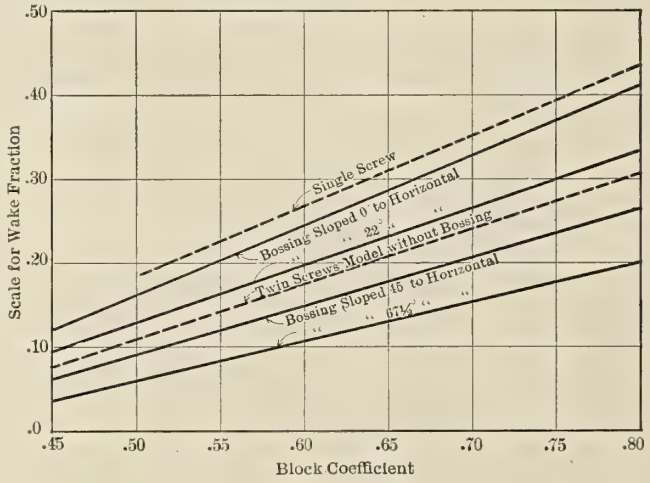


Fig. 3

just as they have been published; but at least it may be hoped that comparatively the results may be found to be useful to those who are engaged in the pursuits of naval architecture and marine engineering.

The whole comparable data on wake presented in my three papers are collected in Fig. 3, which may fairly well suffice for design purposes. The results of analysis of the speed trials in ten different cases, indiscriminately chosen, will serve to show what variations may exist between experimental data and the probabilities of actual facts.

In conclusion, it must be mentioned that this and previous papers could not have been presented to the Institution without the hearty co-operation and indefatigable work of the staff at the experimental tank of Messrs. John Brown & Co., Ltd., Clydebank, to whom my best thanks are due.

WOODEN SHIPS IN DENMARK.—The building of wooden vessels is now well under way in Denmark, and although the start is small, the experiment will be pushed, according to reports from Consul General E. D. Winslow at Copenhagen. The decision in this matter has been hastened by the submarine warfare of Germany. At many ports in Denmark temporary arrangements have been made for the laying down of wooden ships. Many industries are threatened with stoppage, due to the lack of raw materials, and the workers can thus be given employment at the shipyards building these vessels. The vessels are auxiliary sailing vessels of a standard type, having a loading capacity of 500 to 600 tons.

* Trans. I. N. A., Vol. lii, p. 94.

Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships*

Dynamic Balancing of Propellers Necessary to Effect Perfect Running Balance—Instrument Devised to Record Vibrations in Ship Due to Propellers

BY J. J. KING-SALTER, R. C. N. C.

The vibration of ships has been the subject of many papers and much discussion, but, so far as the author's knowledge goes, it does not appear that the particular question of the action of the propellers themselves, in so far as the effect of their running balance has upon vibrations, has been previously brought forward. Since the introduction of turbines in warships as the main engines, running at much higher revolutions than was previously the case with reciprocating engines, the necessity of seeing that the propellers were suitable, not only as regards their form, but also as regards their being in proper mechanical balance, has naturally received more attention.

* Read at the Spring Meetings of the Fifty-eighth Session of the Institution of Naval Architects, London, March 29, 1917.

The object of the present notes is to present the results of some experiments on this point carried out by the author in the course of his work as general manager of the Commonwealth Naval Dockyard at Sydney, Australia, and which the Australian Naval Board has granted him permission to submit to this institution. The experiments to which reference will be made were carried out in two destroyers and a Town class cruiser, which were being built at the Commonwealth Naval Dockyard. In the case of the destroyers, it may be of interest to observe that the turbine engines and the propellers were the first of their kind to be built in Australia, and that, consequently, every care was taken that they should be as perfect as possible.

On test in the shops, under steam, the turbines ran as free from vibration as any one could wish or expect, spe-

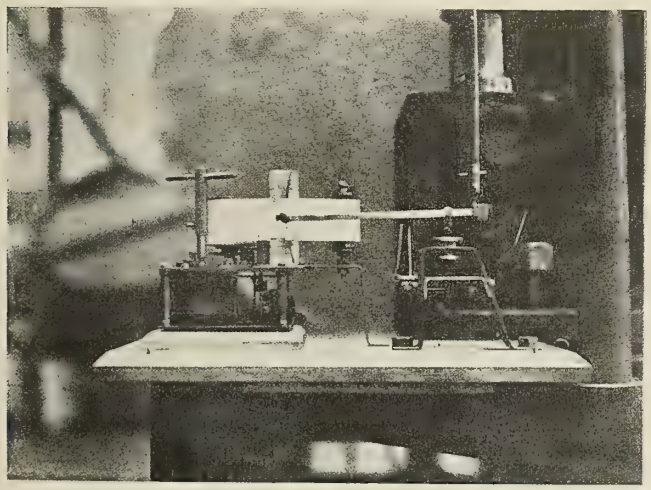


Fig. 1.—Instrument for Recording Vibrations

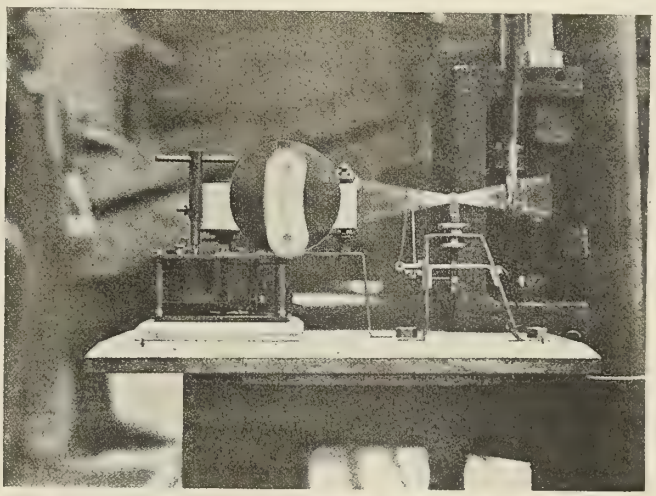


Fig. 2.—Recording Instrument in Operation

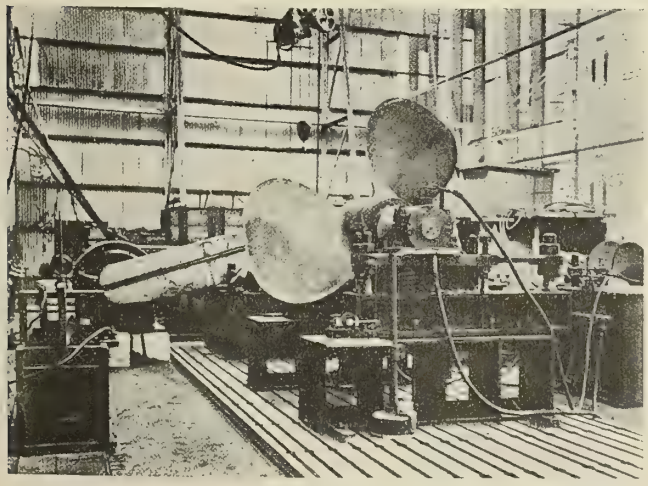


Fig. 3.—Apparatus Used for Dynamically Balancing Propellers

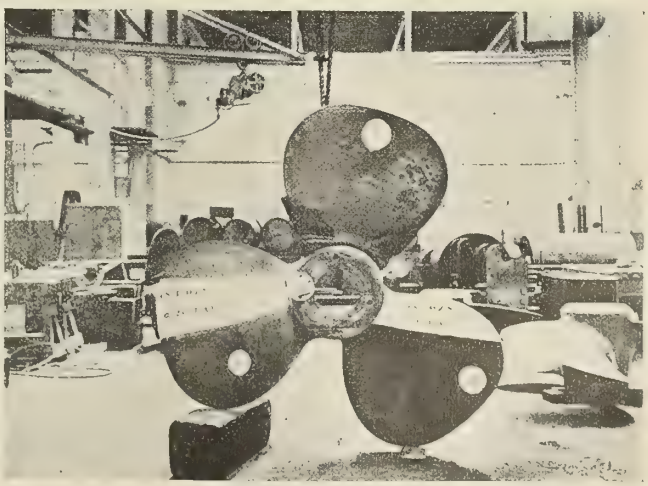


Fig. 4.—Cruiser Propeller with its Balancing Weights

cial care having been taken in their manufacture to insure the rotors being in as perfect running balance as possible, the means adopted to do this being first to balance each rotor on knife-edges to obtain a static balance, and subsequently to mount it on spring bearings, so arranged that the rotor in its bearings was free to move up and down vertically, but not sideways, and then rotating the rotor in its bearings at speed, and by removing weight at the end as found necessary till the rotor ran in its spring-mounted bearings without a perceptible tremor, thus insuring what may be called dynamical balance. No claim is made for any novelty in these methods as regards the rotors, but it is mentioned on account of what follows in regard to the subject matter of this paper.

The usual and most recent practice as regards the manufacture of the propellers for the destroyers was followed, viz.: After being cast, the driving faces were machined to true helics, and the backs chipped and filed to insure as uniform and as accurate a shape as possible, sections being carefully calibrated at frequent radii and made to agree with the designed thickness at each point of calibration, and then statically balanced on knife edges, not between lathe centers, as it was considered and found that knife edges were more sensitive; and, finally, the whole surfaces were buffed to a smooth polish.

The first destroyer to be completed with the Australian-built engines and propellers, made as described above, ran her trials very satisfactorily, but there was a certain amount of small vibration in the vessel, most pronounced right aft above the propellers, of which there were three—one on each of three shafts. The vibration extended right through the vessel, very much diminished forward, but sufficient to cause the hand rails and other fittings in the engine room and fore bridge to shake, being more pronounced on the fore bridge.

Tracing the Source of Vibration

That this vibration was due to the main engines was considered most improbable, as these latter apparently ran as smoothly and as free from vibration as they did in the shop test. The other only rotating masses that could possibly be supposed to cause vibration were the propellers. Was this vibration due to the propellers working in the water with possible interference with each other, and other water causes, or was any of it due to the propellers themselves not being in perfect running balance?

The question then arose, were the propellers, as manufactured, fulfilling the conditions for perfect running balance which, quoting from Mr. Barnaby's book on "Marine Propellers," are given to be:

(1) Each blade must be of the same weight.

(2) The center of gravity of each blade must be at equal distance from the axis of the propeller.

(3) The center of gravity of each blade must lie in a plane at right angles to the axis.

To fulfill these conditions, each part of each blade must be exactly the same shape, the same thickness, and be symmetrically situated around the axis. If this is so, then condition (3) insures that each blade is similarly placed along the axis.

There is no way known to the author for conditions (1) and (2) to be obtained, except by care in casting, marking off, and machining the driving faces, hand chipping and filing the backs, and calibrating sections at frequent intervals to given dimensions. If this was carried out exactly, condition (3) would be naturally satisfied. But in practice it is practically impossible to insure that all parts of each blade shall be exactly of the same thickness, and that all parts of the propeller are exactly and symmetrically disposed around and along the axis.

What check can there, therefore, be exercised to know whether condition (1) or (2) is satisfied, as it is possible for the propeller to be in static balance, and yet for these two conditions not to be fulfilled, and, so far as the author's knowledge goes, he does not see what other method can be adopted to place an absolute check on these two conditions. And, as regards condition (3), hitherto, also, so far as the author knows, no other check other than the static balance and the calibration has been exercised to prove whether this condition has been fulfilled, and it has apparently been assumed that the above checks have been satisfactory.

Dynamic Balancing of Propellers

The object of this paper is to show that there is another check to which propellers can be subjected, viz., dynamic balancing, i. e., the rotating of the propeller at speed on spring bearings, noting the vibration, and the removal of weight from certain parts of the blades and even the boss, the position of which is indicated by the direction in which the vibration acts, in a manner exactly similar to the way in which a turbine rotor is balanced, as mentioned above. It is contended that by this further balance a perfect running balance can be obtained, i. e., one in which the propeller can be made to rotate at any speed in the spring bearings without a perceptible tremor, and presumably, if it will do this in a live bearing, it will similarly run without vibration on its shaft in the ship. Condition (3) is thus satisfied, and also that the mass center of the propeller coincides with center of rotation, but it does not in any way help to satisfy conditions (1) and (2), and, as previously stated, so far as it can be seen, the approximate satisfaction of these two first conditions can only be obtained by careful and accurate workmanship.

As previously stated, if conditions (1) and (2) were exactly fulfilled, and the propeller otherwise also accurately made, condition (3) would follow; but that it does not has been proved by the tests carried out, every propeller so far tested—some twenty-five have been dynamically balanced—not one was without considerable vibration. Some of these propellers were made at the Commonwealth Naval Dockyard, and others have been supplied by various contractors, all of which latter were built under Admiralty supervision and conditions, so that it may not be far wrong to assert that there is probably hardly a propeller made which, if subjected to the dynamical balancing test, would not be subject to vibration.

It is thought that a little consideration will show that this is probably the case, as it is practically impossible to insure that every part of each propeller is exactly symmetrical, when such accuracy depends so largely on hand work to measurements; and, moreover, there is the added possibility of a difference in density in the material, and also the great difficulty at the roots of the blades and at the boss of insuring absolute uniformity, but, by utilizing the centrifugal forces developed when the propeller is rotated, all these discrepancies at once manifest themselves, and with a little care and experience they can be practically entirely eliminated.

It might be supposed that, in the short fore and aft length, such as the average propeller has, the magnitude of the forces about the plane at right angles to the axis would not be great enough to cause much vibration, and that it would not appreciably affect the ship, but the result of the experiments carried out, referred to below, in two destroyers and one larger vessel—a Town class cruiser—show that they do have a very considerable effect. That

this may be so will be readily understood, when it is remembered how great are the forces developed by small weights under centrifugal forces, acting at the speeds turbine-driven propellers have hitherto been run.

It is well known to be unnecessary for running balance, that any number of weights, disposed rigidly around a shaft, shall be of equal weight, nor that their centers of gravity shall be at equal distance from the axis of rotation, but such a system will only rotate in dynamic balance when condition (3) is fulfilled. The conditions for such balance may be found in treatises on statics and dynamics, but reference is specially made to a book by Professor Dalby on "The Balancing of Engines," 1902, page 13 *et seq.* It may be of interest to note the importance attached to the practice of balancing railway carriage wheels referred to in Professor Dalby's book (*vide* page 19), which balancing is practically the same as here proposed for propellers.

The dynamical balance does not, therefore, provide a perfectly balanced propeller, as defined by Mr. Barnaby, but it does provide for one that will rotate without vibration if the balancing is properly carried out. Clearly, if a propeller will vibrate when tested in the shop, such vibration must be transmitted to the ship.

All the propellers hitherto dynamically balanced by the author have been those which had been completed and passed as satisfactory, but in future, in making new propellers, it is proposed, after the shaping of the blades and calibration have been completed, to dispense with the statical balancing, and proceed with the dynamical balance straight away, as the tests carried out in that balance would show whether the out of balance was due to the mass center being eccentric, or whether it was due to condition (3) not being fulfilled. Once the balancing apparatus is provided, it can be safely asserted that the time and cost required to build a propeller will not only be less, but the result will be far more satisfactory, as hitherto the time taken to balance a propeller on the knife edges has been considerable.

Effect on Ship of Eliminating Vibration in Propellers

The next point to determine was how much would elimination of vibration in the propeller affect the ship. To do this it was necessary to have an instrument that would record the small, quick vibrations, but take no account of any of the pitching and rolling motions of the vessel when in a seaway.

At the time the first set of dynamically balanced propellers was tried in one of the destroyers, the author, unfortunately, had no instrument available which would do what was required. A Schlick vibrometer was tried, but in these light vessels, and in an open seaway—no smooth water being available—this instrument, when adjusted sensitively enough to record the small vibrations, was so affected by the pitching that no satisfactory results could be obtained. It can only, therefore, be asserted that in the opinion of the ship's and Dockyard officers—and of the author's—there was a decided improvement. The shaking of the hand rails in the engine room and on the fittings on the bridge had been practically eliminated, and the vibrations aft were considerably reduced.

The author would not have attempted to put forward these remarks had he not something more definite to rely upon than personal opinion, and it was in the subsequent experiments on the Town class cruiser, which was being built at the Dockyard, that he was able to obtain a permanent record of the difference in vibration between two sets of propellers, as made by one of the leading specialist manufacturers of propellers in England, the one set being tried on the ship as supplied by the makers, and the other after being dynamically balanced by ourselves. By the time this vessel was ready for her trials the author had, after much consideration, evolved a very simple means of obtaining a definite record by an instrument which, although it did not give absolute readings of the vibration of any one particular part of the ship, yet gave definite differential readings of the vibration of two parts, which were readily comparable under the two conditions, and which were, for the purpose required, entirely free from the effect of the vessel's movements in a seaway. The principle of the instrument depended upon recording the difference of vibration of two decks, one immediately over the other. It was anticipated each deck would, owing to their different stiffnesses, have a different amplitude of vibration, and that if stiff rods were fixed one to one deck, and the other to the deck over, and pointing to meet one another, and slide over one another at their junction, the relative movements of the two rods, repeating the movements of

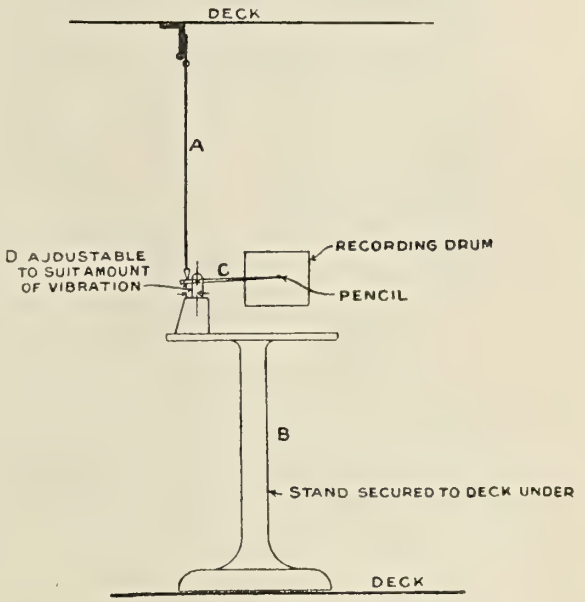


Fig. 5.—Diagram of Recording Instrument

the decks, could, by means of a simple lever, be magnified and recorded on a drum worked by clockwork.

A diagrammatic picture of the principle of the arrangement is shown in Fig. 5; and Fig. 1 is a photograph of the actual instrument.

Referring to Fig. 5, the two rods are represented by the rod *A*, and the standard *B*, both of which move with their respective decks, being secured thereto. The multiplying lever is shown at *C*, and the recording drum, worked by clockwork, is seen under the end of the lever *C*. It was, however, a matter for conjecture as to what would be the amplitude of the vibration to be recorded. The leverage of the recording lever was, accordingly, made adjustable, so that multiplication of the actual movements of the decks could be varied from 50 to 1 to about 5 to 1, by adjusting the length *D*. It was found that the ratio of 25 to 1 gave good readings, and was sufficiently sensitive to show the smallest vibrations. A speed of paper of about 30 inches per minute was also found suitable.

The instrument was put up in the captain's cabin, approximately over the aftermost pair of propellers, of which there were four, one on each of four shafts. The deck over was the upper or weather deck, and the deck under was the protective deck. This latter deck was, by

the nature of its structure, very stiff, and, by its position nearer the neutral axis, less liable to vibration than the upper deck. The instrument recorded, therefore, only the relative movements of these two decks, so that readings of the vibrometer would tend to be either more or less than the real movement of either deck, according to their relative motions.

The readings might be the sum of the movements of the two decks, or their difference, but this did not, it is considered, impair the results aimed at, viz., to obtain relative records between vibrations set up by the two sets of propellers—the one only statically and the other also dynamically balanced.

The trials of this vessel were being carried out with a view to completing her as soon as possible, and, being under war conditions, no time was available to make special sea trials, but such results as were obtained were sufficient is not unreasonable to assume that some of this increase was due to the propellers working under better balance, and, if this was so, a small increase of speed would result, as when a set of propellers, each weighing nearly two tons, even in such a comparatively small vessel as the one in question, are sufficiently out of balance as to vibrate considerably when tested in the shop in the spring bearings before being balanced, and when such propellers are working in the ship, setting up vibration, it is very evident that such vibration not only must cause extra friction in the *A* bracket bearings, and thus tend to reduce the revolutions and general efficiency of the propellers, but must also increase the wear and tear in those bearings, and also in other fittings in the ship generally.

The rates of revolutions given on the records are the mean of the four shafts. The variation from the mean at 493 revolutions amounted to about 15 above and 15 below.

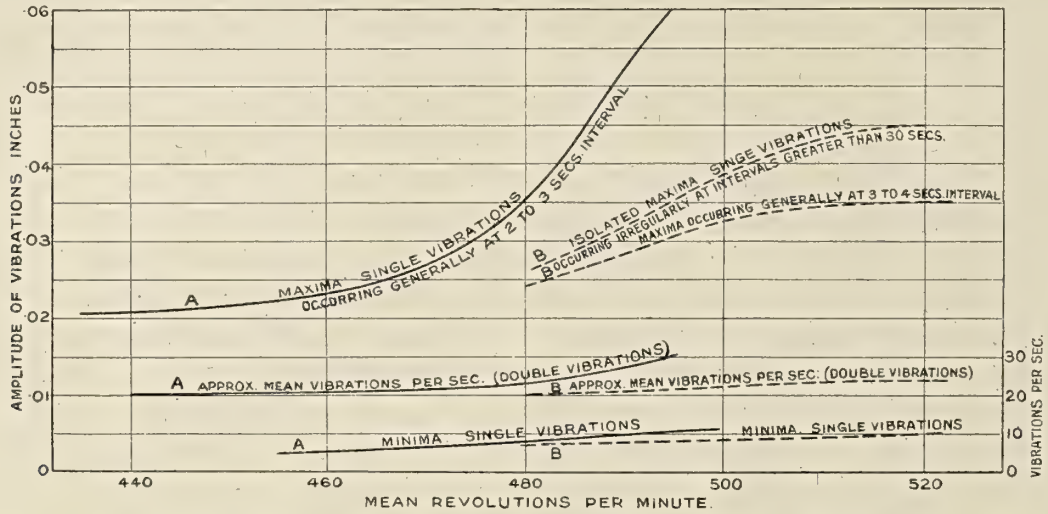


Fig. 6.—Vibrometer Records, Vessel Fitted with Four Propellers. Curves A—Propellers Statically Balanced, Taken on 25,000 and 22,000 Shaft Horsepower, Trials 4-11-16. Curves B—Propellers Statically and Dynamically Balanced, Taken on Commissioning Trials 4-12-16

to show the very marked difference between the two sets of propellers.

In order that the conditions for vibration might be the same, the loading of the vessel in the two conditions was maintained as similar as possible, so that the drafts were practically the same. Fig. 6 shows the curves deduced from the records obtained.

In Fig. 6 the upper curve *A* shows the maximum readings obtained with the unbalanced propellers. It will be observed how, at the highest speeds reached, viz., about 493 revolutions, the vibrations increased at a rapid rate, whereas in the upper curves *B B* the maxima were not only much less but of a different character. In the *A* curves periods of relatively intense vibration, alternating with periods of comparative small vibration, occurred at frequent but varying intervals, whereas in the curve *B* these periods of intense vibration had become so much reduced as to be almost absent, occurring only at long intervals.

The periods of intense vibration felt to the observer quite severe, and were sufficient to cause any objects lying on the cabin table to rapidly dance off, whereas with the balanced propellers, such objects remained on the table. It may be of interest to observe how very small the total amplitude of vibrations really were, *vide* Fig. 6.

It will be noticed that the maximum revolutions with the balanced propellers were higher than with the unbalanced. The greater part of this increase was no doubt due to the stokehold party providing more steam, but it This in itself is a probable source of vibration. It will be noticed that the rate of the vibrations recorded increased slightly as the speed increased, and at the higher speeds was about twenty-five per second, whereas the maximum of each propeller on test in the shop was about ten per second.

It will, it is considered, be admitted that the impressions and assertions of so many persons in the case of the destroyers, and the evidence of the records obtained in the case of the cruiser, cannot be a mere coincidence, and if the author has succeeded in showing that to obtain the best results and to effect perfect running balance it is necessary dynamically to balance propellers, and, so far as he can see, that such balance is unobtainable otherwise, he will rest satisfied, observing, in a time like the present, when our navy is undergoing such a severe ordeal and when our ships are running so constantly at full speed, that anything that can be done to reduce vibration must help considerably to reduce the fatigue of the officers and men, who are now being strained to their uttermost limits As the author can safely say, he would personally have been very sorry to have had to live in the captain's cabin when steaming at full speed with the unbalanced propellers, whereas with the others, although there was still not an inconsiderable amount of noise and vibration, yet the two conditions were so totally different, one of the officers of the ship, without stopping to think, exclaimed: "It is quite 100 percent better," and the author can only say he wished it had been so perfect.

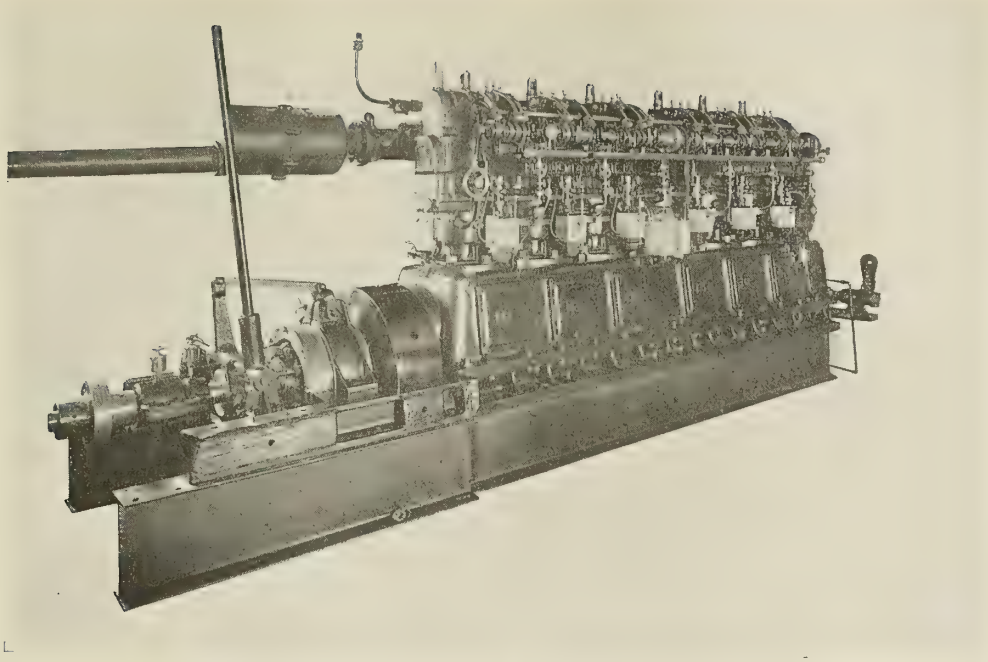


Fig. 1.—Fulton Marine Diesel Engine of 100 Horsepower

Diesel Engine of One Hundred Horsepower

Built by Fulton Manufacturing Company, Erie, Pa. for War Department—Installed in 50-Foot Tender Serving Government Dredges

WHAT is believed to be the smallest oil engine of the straight Diesel type of pure American design and workmanship that has so far been installed in the United States is the 100 horsepower Fulton Diesel engine installed in a 50-foot wooden tender built by the Charles P. Willard Company, Winthrop Harbor, Ill., for the Engineer Corps of the War Department. The boat is being used in connection with river and harbor improvement work on the coast of North Carolina, with Wilmington, N. C., as headquarters. In this work the dredges are sometimes 40 miles from the railroad and the small tender is used for towing water and provision barges to the dredges, moving anchors, etc. The work is particularly arduous and trying on both boat and engine because of the character of the coast. The water is shallow and muddy, and the shallow water easily kicks up into a choppy sea.

The *Manteo,* as the boat is called, is 50 feet long overall by 13 feet beam, 6 feet 6 inches depth of hull and draws 4 feet of water loaded. The engine is a four-cycle, six-cylinder Fulton oil engine of the straight Diesel type, built by the Fulton Manufacturing Company, Erie, Pa. The cylinders are 8 inches by 9 inches, and at a speed of 400 revolutions per minute the engine develops 100 brake horsepower.

Results of Government Tests

Tests of the engine made by the War Department included a preliminary test at full speed for forty-five minutes, and then on the following day a series of tests at varying speeds. The first test was at 322 revolutions per minute, the second at 273 revolutions per minute, the third at 231 revolutions per minute and the fourth at 400 revolutions per minute. The first three runs were for a period of one hour each and the fourth for a period of two hours. In these tests the brake horsepower and fuel consumption were determined. At 400 revolutions per minute the engine developed 100 brake horsepower and consumed 0.53-pound of fuel oil per brake horsepower hour. No difficulty was encountered in readily starting the engine, which ran smoothly and without missing fire throughout

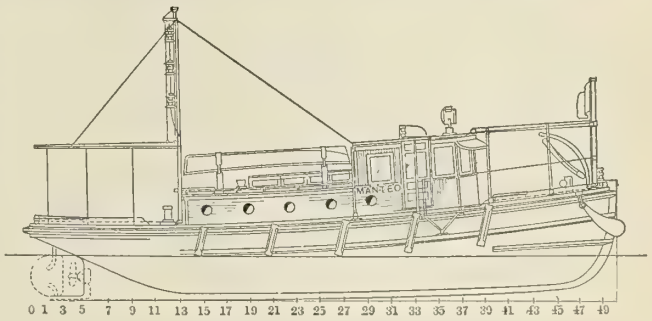


Fig. 2.—50-Foot Tender *Manteo*

the test. The exhaust was clear and without odor. The air pressure for starting the engine and for fuel injection varied from 750 pounds per square inch at low speed to 1,125 pounds per square inch at high speed.

Fuel oil is fed to the engine by gravity from a 50-gallon tank located directly over the engine. An oil pump in the engine proper pumps the oil from the main oil tanks, which are forward of the engine room and under the pilot house, up into this gravity tank. A return pipe to the main tanks makes it possible for the pump to be in continuous operation, the surplus oil being carried back to the tanks. Situated below the gravity tank is a 2-inch pipe in which is a glass gage with a pet cock at the bottom. Any water or dirt will settle in this pipe and can be seen

through the glass and drained off through the pet cock.

As shown in the photograph, Fig. 1, the two-stage air compressor is situated at the forward end of the crank case. From this compressed air is led through a water-jacketed pipe to three steel air bottles tested to a pressure of 3,000 pounds per square inch. The air in one of these bottles is used for the injection of the fuel. As the compressor compresses more air than is required for injecting the fuel while the engine is in operation, the surplus air is stored in the two other steel bottles and is used for starting only. While it is supposed to be very difficult to hold the air at such high pressure, it has been found, on the contrary, that if the valves are properly seated no difficulty will be encountered. As a matter of fact, the air in one of these bottles was maintained at a pressure of 11,000 pounds per square inch for over one month with no appreciable depreciation.

Fuel Pumps and Lubrication

On the starboard side of the engine are the individual fuel pumps, one being provided for each cylinder, so that if by any chance one of the pumps or one of the cylinders fails while the boat is at sea the operator can cut out this one cylinder and continue running the engine with the other cylinders.

Lubrication of the pistons and cylinder walls is by means of a Bosch oiler with two leads to each cylinder. Inside the forward end of the crank case are two rotating pumps, one driving the oil at a pressure up to 15 pounds through the hollow crank shaft and up through the hollow connecting rods to the wristpin bearings. The oil oozes out on the bearings and drops back into the base, which is water-cooled, thus cooling the oil. The oil then passes through a strainer and is returned to the pump. In this way there is a steady flow of cool oil in the bearings, thereby reducing the consumption oil to a minimum, only about 4 quarts of oil being required for a continuous ten-hour run of the engine.

At the forward end of the engine are two heavy bronze plunger pumps for circulating the water and for the bilge system. These pumps are also duplicates, so that if by any chance the water-circulating pump should go wrong when the boat is at sea the operator can immediately connect up the bilge pump with the circulating system and continue running the engine.

Another interesting feature is the fact that the flywheel, instead of being at the forward end of the engine, is at the after end. In this way unnecessary strain is taken off the flywheel. Just back of the flywheel is a Paragon reverse gear.

Propeller

The propeller is a three-blade, style "I," Columbian propeller, 42 inches in diameter by 38 inches pitch, designed to turn at 400 revolutions per minute. As the *Manteo* is a Government vessel, extra heavy stuffing boxes are used on the propeller shaft, each weighing 195 pounds. The bronze shaft is 3½ inches diameter by 13 feet long and weighs 492 pounds.

As economy is a chief point of advantage in a Diesel engine, the following comparison will be of interest. The 100 horsepower Diesel engine installed in the *Manteo* consumes about 6¼ gallons of fuel oil per hour. At 6 cents (0/3) per gallon this would cost 37½ cents (1/6¾) per hour. If the boat is run for three hundred days at ten hours each, the fuel bill would be $1,125 (£230). On the other hand, if a 100 horsepower gasoline (petrol) engine were run a similar length of time, burning gasoline at 24 cents (1/0) a gallon, the fuel bill would be about $9,000 (£1,845). In this case, therefore, the Diesel engine represents a fuel saving in one year of $7,875 (£1,615).

Another remarkable comparison in fuel economy is that of a 70 horsepower Diesel engine which the Fulton Manufacturing Company installed at Sama, Cuba, in a tug owned by the Atlantic Fruit Company, of New York. During the season preceding the purchase of the Fulton Diesel engine, Mr. Middleton, the local manager, was using two gasoline (petrol) engines, totaling about 55 horsepower. His bill for the season for gasoline (petrol) was $2,000 (£410). For the next season, with the Fulton 70 horsepower Diesel engine, the fuel bill was only $130 (£26.6), making a saving to the company in one season of about nine months of $1,870 (£283.4). The vessel on which this engine was installed was a tug used for towing a barge loaded with bananas.

Texas Company's Fleet of Tankers Completed by the Fore River Shipbuilding Corporation

The S. S. *Virginia*, the last of a fleet of four oil tank steamers constructed by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Texas Steamship Company of New York, was recently completed. Two of the fleet, the *Texas* and the *New York*, were completed last year, and are now in service, while the *Pennsylvania* was completed this year. The *Virginia* has two continuous steel decks, a raised forecastle, open bridge, and poop decks, with a lower deck in the package freight hold forward. The hold is divided by oil-tight bulkheads into sixteen main oil cargo tanks, sixteen summer tanks, fuel oil tanks, two pump rooms and a cargo hold, machinery space aft, deep trimming tanks, both forward and aft, and a double bottom under the engine and boilers.

The length over all is 432 feet, and the dead-weight carrying capacity 9,100 tons. The capacity of the main cargo oil tanks is 67,930 barrels, and of the summer tanks 8,634 barrels. Her fuel oil capacity is 10,450 barrels.

The *Virginia* has been designed to carry various grades of refined oil without danger of mixture. The cargo pumping system has, therefore, been worked out to an unusually high point of efficiency, necessitating the use of twelve pumps—eight for the cargo in the main tanks and four for handling the oil in the summer tanks.

The vessel is propelled by a single screw driven by a three-cylinder, triple-expansion engine, steam being supplied by three single-ended Scotch boilers. These boilers are oil-fired on the White atomizing oil-burning system.

The accommodations of the officers and crew are unusually complete.

A Clipper Ship of 1853

(*Concluded from page* 379.)

Ceiling, from bilge to lower deck, 15 inches, scraped and bolted edgewise.

"She has three full decks, securely fastened with fore and aft knees; the hanging knees are extra fastened, having in the lower hanging knees 18 bolts, 1¼-inch iron; middle deck, 20 bolts; also upper deck hanging knees, 20 bolts and all of oak. Beams in lower deck, 14 by 16; in middle deck, 15 by 17; in upper deck, 12 by 16, and some 12 by 20 inches.

"Lower deck main hatch is 14 by 20; middle deck, 14 by 16, and main deck 14 by 11.

"She has a hurricane deck over all, merely for working

the ship, thereby obviating the difficulty in obstructions from houses, spare spars, water casks, etc.

"Her mainmast is 126 feet long, 98 feet above deck; diameter, 44 inches; masts made of hard pine, to carry two stationary yards with trusses, the same as used on lower yards; fore and main deck alike, and those on the mizzenmast the same as those on the other masts above the lower yards, so that, except the courses, all her sails will have duplicates on every yard fore and aft. Her main yard is 110 feet long, the others in proportion; she will have a fourth mast, principally to lead the mizzen braces, to prevent the difficulty arising from mizzen braces leading forward and hauling the mast out of place.

"The model of the ship was said to promise a combination of swiftness, buoyancy and beauty that has never been excelled. Notwithstanding her vast size, such is her length and buoyancy that, when loaded ready for sea, her draft of water will not exceed 23 feet, a common draft for ships half her size."

Unfortunately, Sir Joseph Whitworth omits the names both of the vessel and her builders, and more detailed particulars might have been given. However, upon the evidence of Frank T. Bullen and others the United States turned out at about the middle of last century the finest and fastest clipper ships ever built. It is hoped that the present activity in an industry so long decayed lends a present interest to the extract given above.

London. A. L. Haas.

Mission of the Gyroscope in the Marine Field

BY ALBERT W. STRINGHAM*

ONE of the earliest investigators of the gyroscope was Edward Sang, of Edinburgh, Scotland, who in 1836 announced that he had discovered certain gyroscopic principles but was unable convincingly to demonstrate them owing to his crude apparatus. Credit is due Leon Foucault, a French physicist, for the first demonstration of the gyroscope's phenomena. It was, however, left to the well-known American author, Hopkins, of the *Scientific American* (1876), first to apply an electric motor to apparatus similar to Foucault's, and with this device Hopkins was enabled to obtain much more definite and persistent results.

While the gyroscope of Hopkins would indicate true north on land, it was found to be tremendously influenced by accelerating and retarding forces when attempt was made to use it on a moving ship, and for navigating purposes it was therefore wholly useless. Many other workers then took up the task of producing a mariner's gyro-compass, but a score of years elapsed before success came. Dr. Anschutz-Kaempfe, of Hamburg, Germany, finally succeeded in constructing a gyro-compass (1905) which would for a short time hold the meridian, despite speed, course, latitude and roll of the ship—a truly wonderful achievement when one considers that the directive force which the gyro-compass receives comes from a point some 4,000 miles distant—i. e., *the axis of the earth.*

Coincident with the work of Kaempfe was that of Dr. Schlick (1904), the well-known Hamburg scientist, who produced the first stabilizer, using a "passive" gyro; then Brennan and Froelich built monorail cars.

During this time there was another worker in the field; few knew of his activity, none knew what he was accomplishing. He alone understood that the discoveries of his co-workers, which were being heralded as "inventions of tremendous commercial value" were really based on wrong principles. This man was Elmer A. Sperry, of New York. Five years ago the United States Government tested his first gyro-compass and to-day every United States battleship, cruiser and submarine is equipped with it, as are the ships of nearly every first-class navy of the Old World; a number of battleships, transports and private yachts are stabilized by his "active" gyroscope; his gyroscopic aeroplane stabilizer recently won first prize in competition with nearly every type of aeroplane stabilizer manufactured, and in 1915 he was elected a member of the United States Naval Board.

In addition to the Sperry "master compass," repeater compasses, electrically connected with the master compass, are located at various parts of the ship. An interesting feature is the "hunting" or vibrating of the repeater compass cards; should this cease the navigator would be warned of some mechanical derangement. The large bowl houses the gyro wheel which spins within its vacuum case at the rate of 8,000 revolutions per minute. The entire apparatus is simple, compact and of wonderful durability—many compasses have been run continuously for months without replenishment of oil or other attention.

The "active" gyro equipment devised by Mr. Sperry for overcoming the rolling of ships consists of three elements: a gyro wheel, a precession motor and a gyroscopic control. The control is so extremely sensitive that it "feels out" the incipient roll of the ship and directs the precession motor which moves the gyro. When the ship manifests a tendency to roll, but really before motion sets in, the control gyro responds to the impressed force of the wave and quickly precesses, closing one contact or the other, energizing the motor which moves the large gyro; the large gyro then actually lays hold of the longitudinal stability of the ship and transfers it athwartship; and this action is repeated first in one direction and then the other, instantly and automatically meeting each fresh energization and quenching it.

As the ship is never allowed to roll very little power is required, each wave being dealt with individually; no sudden stresses are thrown upon the hull, as the forces start at zero and return to zero. The gyro constitutes an ideal apparatus for this sort of work, inasmuch as it is perfectly safe. The comparatively slow motion of the wheel is very inexpensive to develop and maintain, representing only a small fraction of the power required to propel bilge keels; and this power, small as it is, is only required when necessity for stabilizing arises, and then only in proportion to the seas running at the time, where the power for the bilge keels is omnispresent; that is, it is a constant drag in all weathers.

In conclusion it might be of interest to add that whereas the weight of Thornycroft or Frahm anti-rolling tanks equals approximately one-twentieth the ship's displacement, the complete gyroscopic stabilizing equipment constitutes considerably less than 1 percent thereof.

* The Sperry Gyroscope Company, Brooklyn, N. Y.

World's Largest Dry Dock.—It is now fully expected that the mammoth graving dock which is being built for the Canadian Government at Levis, Quebec, will be ready for service very soon. With a length of 1,150 feet, a width of 120 feet, and a depth of 45 feet, it will be the biggest structure of the kind in the world. Docks of similar size have been planned for the Dominion authorities at St. John, N. B., Halifax, N. S., and at Vancouver, B. C. Canada will therefore be fully equipped for docking the largest vessels that are likely to be built for years to come.

Letters from Marine Engineers

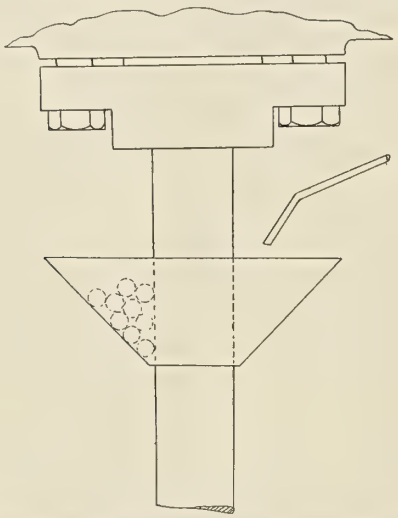
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Method Used for Lubricating Vertical Shaft

On a recent trip trouble was experienced with steam leakage on the piston rod of one vertical engine, and no remedy was of avail until a metallic packing was used in the stuffing box. While this stopped the leakage, it resulted in excessive friction and scoring of the rod.

To overcome this we decided to give better lubrication to the rod, and devised an arrangement as shown in the



Sketch of Oiling Device for Vertical Shaft

sketch for oiling the reciprocating shaft. A shield (conical in shape) was placed around the shaft, into which were placed some steel balls for the purpose of evenly distributing the oil, which was introduced drop by drop through the oil pipe shown. This method worked out very satisfactorily and kept the rod in good shape until the end of the trip, when permanent repairs and overhauling could be made.

Philadelphia, Pa. W. A. Lailer.

Getting the Idea

It is rather annoying for those in charge to deal with the fellow who does not seem to get the hang of things. Perhaps little, if anything, counts up more to favor a man's advancement than ability to catch the ideas and thought of his employer or immediate superior. When certain instructions are being given to you about the work in hand, etc., you must form the trait of getting the idea, or meaning, and not have to be constantly consulting your chief about what to do. Some fellows listen to instructions, and after the chief has finished them will say that they understand them; yet when they try to carry out these instructions they mix things up, or perhaps act to the contrary. This very plainly shows that they failed to get the chief's meaning or ideas.

A fellow must use his thinker to make good at steam engineering. Failure on your part to do your share of thinking burdens your fellow men and your chief with the task of thinking for you, and places you in the ranks of sluggish failures.

You have been allotted the same amount of gray matter that your fellow men have. There is but one way to develop the thinker, and that is to train yourself to be attentive to instructions and reason out why they were given. You would not voluntarily put your right hand in a sling and try to do all of your manual work with the lone left hand. Then why not use the full power of your thinker instead of voluntarily allowing it to go into disuse by letting the chief do your thinking?

When you begin to think for yourself, you will then be able to take the initiative in many things. Initiative is the power to plan and to supply the right ideas and carry them out. It is the key to unlock the shackles of the slave to drudgery and carry you to leadership and mastery.

Chief.

Block Signal for Marine Engines

No doubt most marine engineers have experienced (or at least heard of) the old, old mistake which happens on the best regulated of boats—that of improper handling of the engines, according to orders from the bridge. Much needless damage has been wrought in the past to fine ships and many docks, to say nothing of lost "papers" and, what might be considered worse for the engineer, the loss of prestige. And all because some insignificant, trivial thing occurred to distract the engineer's attention

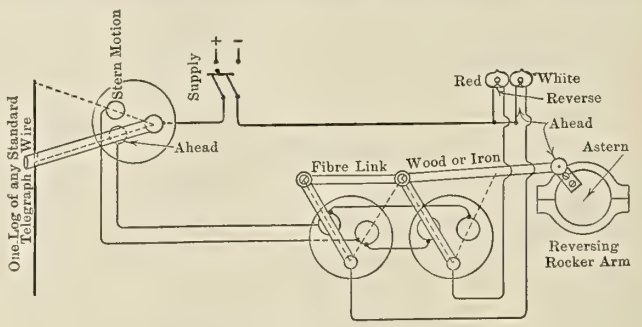


Diagram of Block Signal Arrangement

at a time when his faculties are running more or less along a mechanical rut of thought, rather than the true principle of the thing.

I shall not attempt to discuss just what constitutes a good engineer in the making, but rather have in mind what has happened in the last and suggest something to boost his many fine qualities as well as the reliability of the "black gang."

The following is offered to those young engineers who possess a slight knowledge of electricity and who have usually that "snippy" feeling when the "Old Man" stands just at their elbows during each operation of answering

bells. They are the men who will profit and win approval with a smile of encouragement from the "chief."

Go up town to some electrical supply house and spend less than a dollar of your own change in securing three small two-point switches and some No. 12 wire or heavier. Possibly all the material can be found in the ship's storeroom. If so, you will be ahead of the game.

Proceed as per "sailing directions" given in the sketch for your own amusement and profit and become insured against that moment you fear as you would a submarine.

This simple, reliable electrical block system suggested may be "hooked up" either to ring a bell or to run from the regular lighting service to light red and white lamps, whichever is most convenient and may be depended on automatically to jog the operator's memory in case he works the engine contrary to telegraph orders.

Harry A. Livingston.

Cracked Engine Column Repaired at Sea

The following is an account of a recent breakdown and the repairs effected on a ship on which the writer was engaged in the engineering staff. During a lull in a somewhat severe storm, it was observed that a crack had developed just below the top flange of the low pressure front column. The extent of this crack, as may be seen from the accompanying sketches, was approximately from the inside bolt hole on "after side" of column—round the back—and to the corresponding hole on "forward side" of column. While the engine was in motion, and due to the stresses set up, the crack was noted as opening and closing to quite an appreciable extent. It was consequently deemed advisable to effect an immediate repair

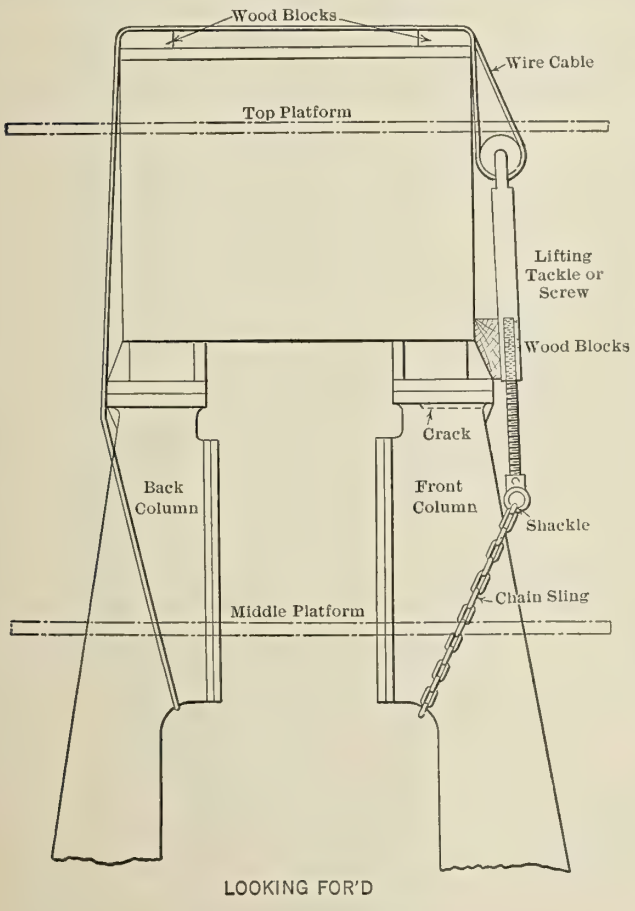


Fig. 1.—Temporary Repair

while the weather had so moderated, and especially as it was learned from the deck department that there was every sign of the storm rising again very quickly.

The temporary repair consisted of the utilization of the lifting screw for the cylinder covers, piston junk rings, etc., being adopted as a chain screw and being placed in such convenient position as to be accessible for tightening up as required. A chain sling was attached round the affected column below the guide, and by means of a shackle to one end of this temporary chain screw, while

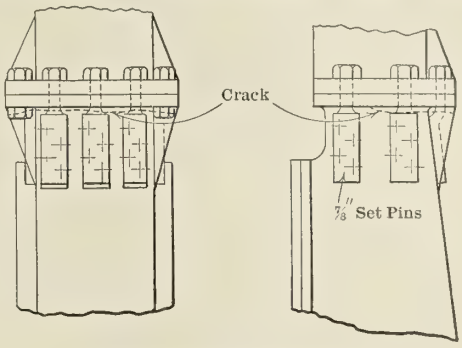


Fig. 2.—Permanent Repair

round the roller end of screw a long length of wire cable was passed, and after being run over the cylinder top was led down beside the back column and passed round below the guide (similar to position of chain sling on front column) and then back over the cylinder top again to the roller. The wire was wound 5 or 6 times, and the ends then made fast. A good strain was then put on screw and the engines slowly started away, this repair only taking twenty minutes.

As the repair was observed to be satisfactory, the engines were soon full away again. In the meantime orders were given to take up a little strain every hour for a time to compensate for the slight "giving" of the wire. Upon reaching port, four days later, a permanent repair was effected by the substitution of bolts, made as shown, the bolt heads being of rectangular section and made fast to the column by ⅞-inch "set pins," as we term them on the Clyde.

The cause of the development of such a crack was attributed to the severe stresses set up by the excessive racing over such a prolonged period (as we were in the storm for fully five days and nights), in conjunction with the slacking back slightly of the column head bolts.

Govan, Scotland. G. M.

A Peculiar Accident

A peculiar and apparently unexplainable accident occurred recently to a boiler in a fishing steamer while tied up to her wharf for the night.

This vessel was fitted with the two Almy watertube boilers, two furnaces each, placed alongside of each other about amidships. When the vessel had been tied up for the night the injector was started while the fires were being banked, and run until the water overflowed into the steam pipe and stopped the injector. The fires were banked by shoving back and covering over with green coal.

About 10 P. M. the engineer went below before going to bed and found everything all right, but at 5 A. M., when the fireman was starting to spread the fires, the sections in the back end of one furnace were found melted together on a line with the top of the fire where banked. No water was found in either boiler.

The apparently unexplainable part of this accident is the fact that neither the sections in the other furnace of this boiler, or any of the sections in the other boiler were damaged; also the cause of heat intense enough to melt the sections that were damaged was a mystery, it being very evident that a banked fire would not engender enough heat to melt them, even when they were dry. The portions of the sections in direct contact with the fire were not damaged, while the entire sections above the level of the fire were fused together.

J. S.

Finding Faults in Cables and Connecting Wires

Faults in cables, and the wires leading from them to lamps, motors, switches, etc., are usually very difficult to find. It is much easier to find them with the modern arrangement of distribution, where feeder cables lead from the main switchboard to distributing boards at fixed points that are conveniently placed; and sub-feeders lead from the distributing boards to branch distributing boards, also at fixed points easily got at, from which the smaller connecting wires lead to the lamps and switches, than with the older method, the tree system.

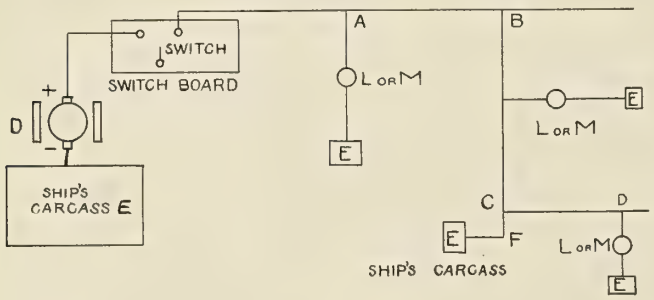


Fig. 1

The insulation of cables very often deteriorates, sometimes at a slow rate, sometimes more rapidly; none of the insulating materials will stand wet or oil; and all of them are very susceptible to mechanical injury. Where a ship is exposed to large changes of temperature, as where she is trading between the Tropics and some port where the temperature is very low during some parts of the year, the stresses set up by the difference in the expansion and contraction of the different substances of which a cable is formed are also apt to cause damage to the insulating envelope and often to open the way for further deterioration of moisture.

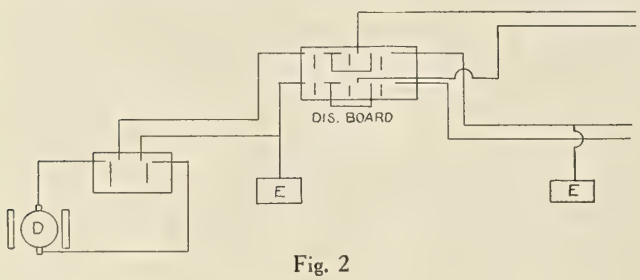


Fig. 2

Where the single-wire system is employed, when the hull of the ship forms the return conductor, faults are more easily discovered, because only one fault is sufficient to cause a breakdown; but against that there is the distinct advantage that with the double-wire system, in which the return currents are carried by a second set of wires and cables, it takes two faults to cause a breakdown. Fig. 1 illustrates diagrammatically how a single fault on any cable in the single-wire system causes a breakdown, because the whole of the current flows through the fault, and through the hull of the ship, back to the generator, in place of through the lamps or motors. Fig. 2 shows how it is necessary for two faults to occur on the two-wire system before a breakdown can occur.

With a single fault there need be no interference with the working of the lamps or motors; but when a second fault occurs the current passes from the fault in the positive cable to the hull of the ship, and thence from the hull of the ship to the fault in the negative cable, and thence back to the generator. The difficulty with the two faults on the two-wire system is: they may be in quite different parts of the ship—that on the positive wire may be in the forecastle, and that in the negative wire in the afterhold, to take extreme cases.

By a fault is meant a connection, either directly or indirectly, between the cable carrying the outgoing current and that carrying the incoming current; with the single-wire system the connection is made directly between the conductor of the cable and the hull of the ship; the connection may be made between the copper conductor and the iron armor where that is used, or the lead covering where lead is employed, and between the armor or the lead and the hull of the ship. The connection causing the fault is due to the insulation of the conductor having broken down, and usually a spark having passed between the conductor and the armor, or the lead, or even the frame of the ship itself, usually welding the conductor to the other metal that received the spark. With the two-wire system two such connections are made between the copper conductor and some metal in contact with the frame of the ship; but where the positive and negative cables are fixed close together, either in the twin form or separately, a direct connection may be made between the two, as shown in Fig. 3. Electrical engineers call these faults "short circuits" or "shorts"; they form short paths for the current to flow round in place of flowing through the lamps and motors.

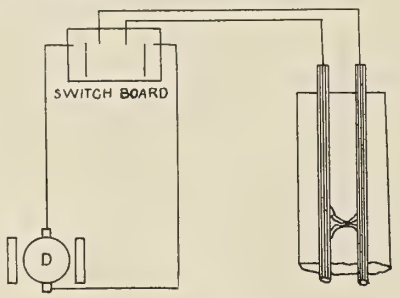


Fig. 3

A point should be noted in connection with the action of short circuits; it will easily be understood that when a "short" occurs between two feeders, leading from the main switchboard to a distributing board, all current is cut off to lamps and motors beyond; but it is not so easy to understand that a short may occur right at the far end of a distribution service, say between two small wires leading to a single lamp or to a small motor, and it may cause the temporary cessation of supply of current to a large portion, sometimes to the whole of the lamps and motors in the ship. The reason for this is, the "short," by removing the resistance of the lamps, motors, ec., by bridging them over, with a very low resistance, causes the flow of a very

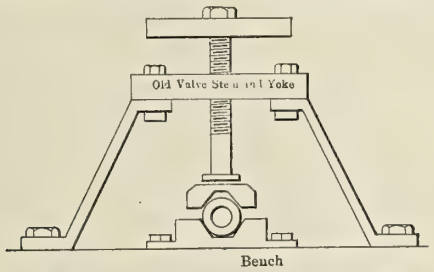
powerful current through all the cables and wires that are connected to those in which the "short" has been formed. The flow of this large current causes a heavy fall of pressure right throughout the distribution service, in accordance with the formula $E = CR$; where E is the fall of pressure in volts, C is the current flowing in amperes, and R is the resistance in ohms.

The distribution service is so arranged that when the lamps and motors are in use the fall of pressure between the main switch board and any individual lamp or motor is very small, not more than 2 volts in a 100-volt service, or 5 volts in a 200-volt service; when the larger current due to the "short" is flowing, the drop in voltage may easily be 50 to 80 volts on 100-volt service, and proportionately on a 200-volt service, or even more.

Bath. SIDNEY F. WALKER.

Extra Bench Pipe Vise

We had a large size globe valve lying in the junk bin of the storeroom. It had been reseated many times, and therefore of no further use. One of the oilers removed



Bench Pipe Vise Formed by Stem and Yoke of Large Globe Valve

the yoke and valve stem from it, and with a couple of pieces of flat 1¼ by ½-inch wrought steel stock, and a few bolts, made an extra pipe vise. This has come in very handy, and as the V blocks are portable the vise can be used for holding down square stock to the bench.

JUNIOR.

Read the Ads.

As I look through the ads. in my trade magazine,
I think of their value and just what they mean.
I know where I'm at, and don't have to converse
With salesmen whom sometimes I afterwards curse.

They tell me how wonderful all their goods are;
Much better than others! You'd have to go far
To find better value! They're best in the land—
And thus they go on with their stories so grand.

They won't put in writing the things that they say,
It means backing up claims! That's out of their way.
But—the ads. that I read make me know where I'm at;
I'll get value received—I'm certain of that.

Concord, N. H. C. H. WILLEY.

SHIPPING BOARD BUREAU OF SEA SERVICE.—The establishment of a sea service bureau, with Henry Howard, director of recruiting, in charge, is announced by the Shipping Board. The object of the new agency is to arrange positions for men graduated from the navigation and engineering schools recently established by the board. Its headquarters will be in Boston.

These schools have been started at various colleges with the object of training men who have had experience as either engineers or seamen to be officers of the merchant marine. The first class was recently graduated from the school at Harvard University.

BOOK REVIEWS

THE TRADE OF TO-MORROW. By Ernest J. P. Benn., Pages, 252. London, E. C., 1917: Jarrolds Publishers, Ltd. Price, 2/6.

Of vital importance to the commercial interests of each one of the nations now allied in the struggle against the Teuton powers is "the trade of to-morrow," or trade conditions after the war is ended. The author is an authority on the subject of trade, having already published a book reviewed in these columns entitled "Trade as a Science." As an Englishman, Mr. Benn naturally looks at the subject from the point of view of his own country, but the subject is covered in such a broad manner as to make the book of universal value. Practical and detailed proposals are made for the reconstruction of British industry after the war, and this subject is treated not only from the viewpoint of the employer, but also from the equally important viewpoint of the laborer.

HANDBOOK OF SHIP CALCULATIONS, CONSTRUCTION AND OPERATION. By Charles H. Hughes. Size, 4⅝ by 7 inches. Pages, 740. Illustrations, 115. New York, 1917: D. Appleton & Co. Price, $5 net.

As announced in the preface, this handbook has been compiled for the purpose of assembling in a single publication, in convenient form, practical data for every-day reference, for men engaged in the designing, building and operating of ships—theoretical calculations being purposely omitted. The book is divided into ten sections, dealing with the following subjects: (I) Weights, Measures and Formulæ; (II) Strength of Materials; (III) Shipbuilding Materials; (IV) Ship Calculations; (V) Hull Construction; (VI) Machinery; (VII) Electricity; (VIII) Heating, Ventilation, Refrigeration, Drainage, Plumbing and Fire Extinguishing Systems; (IX) Ship Equipment, and (X) Ship Operating.

While the book contains a great deal of extremely useful information and data for the various classes of men which it is intended to reach, it must be obvious at once that the scope of the work is too broad for the author entirely to fulfill his purpose. In the preface, for instance, the author claims that such subjects as electric propulsion, geared turbines, Diesel engines and oil fuel are fully treated, as are also recent and special types of construction, such as tankers, battle cruisers, submarine chasers and submarines. As a matter of fact, in the case of battle cruisers, for instance, only a single paragraph of less than a page length is given, and in this case, at least, the subject can hardly be said to be fully covered. Similarly, under the heading of weights of turbine machinery, no specific figures are given, but the subject is passed over with a brief statement to the effect that with turbines there is a saving of weight and space. With the extensive use of steam turbines in both naval and merchant ships, there surely should be available data covering actual weights of such machinery in specific cases. In the case of reciprocating engines valuable data of this kind are given.

The above cases are, of course, by no means a measure of the value of the book, for such sections as those dealing with hull construction, structural details and ship equipment contain much data that are not readily accessible elsewhere.

UNITED STATES MAY BUILD RIVER FLEET.—The feasibility of the government constructing a fleet of barges for the Mississippi and other Western rivers to ease the burden of traffic on the railroads is being considered by the Department of Commerce.

Questions and Answers for Marine Engineers

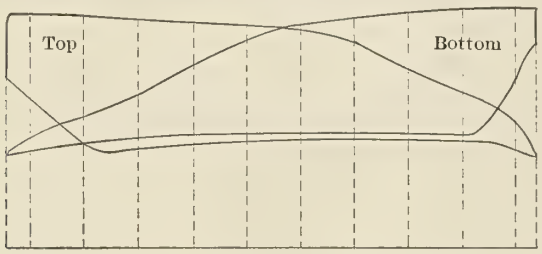
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

BY H. A. EVERETT *

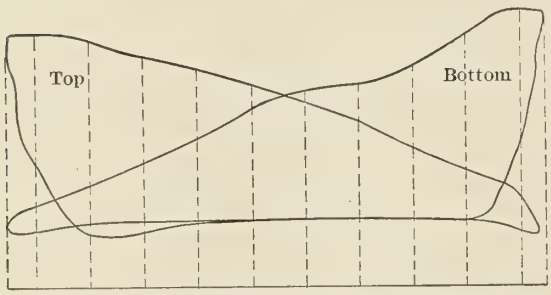
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Analysis of Indicator Cards

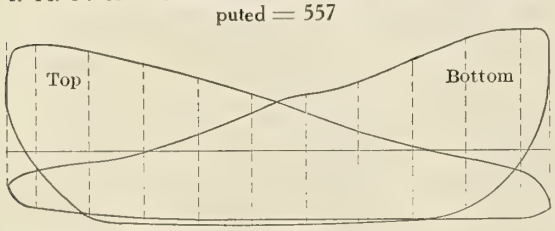
Q. (868).—Please give an analysis of the enclosed indicator cards. I am of the opinion that much better results could be had by a better distribution of the power, but will be pleased to have your opinion of this matter.



I. H. P. of High Pressure Card as First Computed = 404



I. H. P. of Intermediate Pressure Cards as First Computed = 557



I. H. P. of Low Pressure Cards as First Computed = 759.
Total I. H. P. = 1,720

A (868).—The recomputation of the cards by means of a planimeter is given below and differs but slightly from the results attached to the cards:

$$\text{H. P., high} = \frac{2 \times 60 \times 4 \times 490.9 \times 58}{33{,}000} = 414$$

(M. E. P., top, 50.0; bottom, 55.0)

$$\text{H. P., int.} = \frac{2 \times 29.25 \times 4 \times 1{,}320 \times 58}{33{,}000} = 543$$

(M. E. P., top, 32.0; bottom, 26.5)

$$\text{H. P. low} = \frac{2 \times 14.2 \times 4 \times 3{,}632 \times 58}{33{,}000} = 725$$

Total H. P. = 1,682

(M. E. P., top, 14.6; bottom, 13.8)

The card from the low-pressure cylinder presents no abnormal features and is good for this type of engine. The cards from both the high and intermediate cylinders, however, show serious defects in the exhaust line, both showing a serious restriction and consequent rise in pressure in a line which should be horizontal and level with the lowest pressure at the end of the toe of the card. It is more noticeable in the high-pressure cylinder and causes a serious reduction in power (probably over 150 horsepower) for this cylinder. This increase in pressure on the exhaust stroke may be due to insufficient port opening of the valves or insufficient area of passages to the receiver.

If the exhaust lap of the valve on both of these cylinders does not entirely uncover the exhaust port when the valve is in its position of greatest displacement, then either increasing the valve travel by increasing the eccentricity or decreasing the amount of the exhaust lap will probably remedy the defect, but if the ports are entirely open, then the trouble lies in the restrictions which the passages offer and the remedy is difficult.

If you will send on the dimensions of these passages, I will tell you whether the trouble lies with them or not.

Data from Indicator Cards

Q. (896).—Will you kindly answer the following questions in reference to the inclosed indicator cards: Valve gear is Stephenson link motion, slide valves on I. P. and L. P., piston valve on H. P., all taking steam on the outside. The engine is very slow in picking up her speed astern, and one can see that the I. P. engine is being dragged along.

(1). Is this caused by too much angular advance of the eccentric?

(2) If so, and it is to be reduced, kindly give formulæ and example for doing it.

(3). Kindly criticise the inclosed cards and suggest how the I. P. engine indicated horsepower can be increased without greatly altering the power of the other engines.

(4). When taking the atmospheric line of an indicator card and using a one-way cock in conjunction with the usual three-way cock, after shutting the three-way cock, should the pin or drain hole in the one-way cock be set to allow the atmosphere to communicate with the indicator or should it be shut off entirely?

(5). Have I computed the horsepower correctly?

A. (896).—(1) The loop in the cards will be eliminated and the area of each increased by decreasing the angular advance, and this should be done. It is doubtful, however, if the irregularity in turning moment which you notice is principally due to the intermediate cylinder. From the low pressure card for the ahead condition there is a decided difference in the work done on the top and bottom ends, and if the same condition is in evidence when reversed it is probable that this is the principal cause.

(2) There is no fixed rule for the amount of reduction of angular advance, your engineering experience and judgment will have to suffice. It is sometimes helpful to lay out on the indicator diagram the points where you wish the event under discussion (in this case compression) to occur. Draw a semi-circle with the atmospheric line as a diameter, and on it project the original and the new points, draw radii to these points and the angle between will be approximately the angle which the crank should

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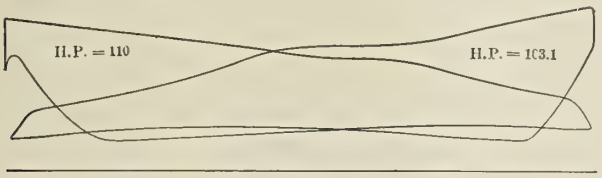
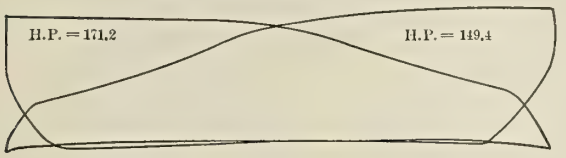
* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

be turned through from the original point of compression to the new position at which the valve should be reset to horsepower could not be computed.

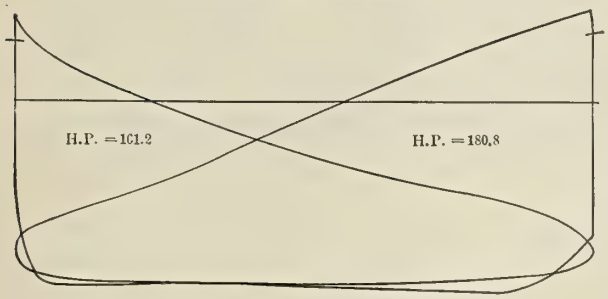
(3) The principal defects in the cards are the inequality in the work of the top and bottom ends of the low pressure cylinder and the small amount of work done by the



High Pressure Cards

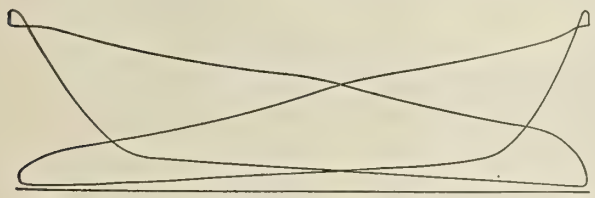


Intermediate Pressure Cards



Low Pressure Cards

intermediate cylinder. This latter will be helped by lengthening the cut-off of the high pressure cylinder. This would be done most easily by adjusting the gag-screws on the high pressure links. It would also help matters to lengthen the valve rod slightly. This would equalize the cards somewhat, as it would advance cut-off and release and delay admission and compression for the top end and



Astern Card

would have the converse effect for the bottom end. The low pressure card would also be much improved by a change in the length of the valve rod. In this case, however, the rod should be shortened. This will delay cut-off and release and advance admission and compression for the top end, which will tend to equalize the areas.

(4) The cock should be so set that the cylinder of the indicator is in free communication with the atmosphere whenever the atmospheric line is drawn.

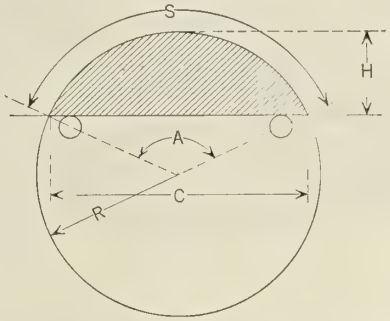
(5) The detailed computation for horsepower is given below. Apparently you did not take account of the areas of the piston rods. In the computations appended it was assumed that there were no tail rods; if such is not the case the results should be changed to conform. As the revolutions were not given for the astern condition the horsepower could not be computed.

Cyl. H. P.	Area, Sq. Ins.	Length Ins.	M.E.P.	Spring	Piston A	I.H.P.	
Top	2.86	4.02	56.9	80	380.1	154.8	
Bottom ...	2.92	3.96	58.9	80	360.7	152.0	306.8
Int. P.							
Top	2.21	4.28	15.49	30	962.1	106.6	
Bottom ...	2.20	4.28	15.41	30	946.0	104.3	210.9
L. P.							
Top	4.08	4.23	7.72	8	264.2	146.0	
Bottom ...	5.03	4.23	9.50	8	262.3	177.9	323.9
Total							841.6
ASTERN COND.							
I. P.							
Top	2.22	4.18	15.94	30	962.1		
Bottom ...	1.97	4.18	14.12	30	946.0		

Area of Segment of Boiler Head

Q. (904).—How do you figure the area of the space between the top row of tubes and the boiler shell in a Scotch boiler?

A. (904).—The area above the tubes will be the area of a segment of a circle shown cross-hatched in the accompanying figure. The easiest way to compute this area is from a table of areas of circular segments, such as is given



Sketch Showing Dimensions for Computing Area of Segment

in most handbooks (see Pocket Companion, issued by Carnegie Steel Company), which gives coefficients by which the product of the chord and rise may be multiplied to get the area at once.

Two formulæ for this area are given below:

$$\text{Area} = \tfrac{1}{2} R^2 \text{ [rad. } A - \text{sine } A] \quad (1)$$

$$\text{Area} = \tfrac{1}{2} [R (S - C) + C H] \quad (2)$$

rad. A is the angle A in radians or the length of arc divided by the radius.

Movement of Valve Due to Movement of Eccentric

Q. (903).—Diameter of shaft, 15 inches; throw of eccentric, 5 inches; how much will the valve move if the eccentric is moved ⅛ inch?

A. (903).—The valve will move anywhere from ⅛ inch to 0 inch, depending upon the location of the eccentric when the movement is begun. The length of the eccentric rod is great compared with the eccentricity, and we may assume harmonic motion, in which case, if the eccentric is on a dead center, the movement of the valve is

$$5 - \sqrt{(5)^2 - (\tfrac{1}{8})^2} = O,$$

very nearly.

If the eccentric is at 90 degrees from the vertical, the movement will be ⅛ inch, very nearly.

British Warships Building in the Orient.—Vessels are under construction for the British Government at Kobe, Yokohama and Hong Kong. At the Kawasaki dockyard, on June 26, a cruiser developing 16½ knots was completed for Great Britain.

LAKE WASHINGTON CANAL FORMALLY OPENED

Completion of $5,000,000 *Project Marked by Fitting Ceremonies on July* 4

Fig. 1.—Lake Washington Canal Locks. From Left to Right—Pumping Station, Large Lock, Auxiliary Lock, Salt Water Drain Spillway, Fish Ladder

Fig. 2.—Admiral Peary's Polar Exploration Ship *Roosevelt* Leading Pageant Through the Canal at Formal Opening on July 4

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

UNITED STATES WILL BUILD GREATEST FLEET OF DESTROYERS IN THE WORLD

Appropriation of $350,000,000 Will Be Asked from Congress

Shipbuilding facilities in the United States will immediately be expanded so that the output of torpedo boat destroyers can be doubled or trebled during the next eighteen months. For this purpose an appropriation of $350,000,000 is being asked by the Navy Department.

The above proposal was discussed at a recent conference between the Secretary of the Navy and representatives of twenty-five or more ship and engine builders. According to the shipbuilders, this large building programme cannot be undertaken without financial aid from the Government. The specific demands from the shipbuilders were as follows:

The Government must finance the establishment and building of the plants.

The plants must be entirely new, as all now in existence are being worked to their full capacity.

The shipbuilders will be willing to accept contracts on a percentage basis.

The Government will have to condemn the land on the sites where the plants are to be situated.

It is understood that the Navy Department is in favor of concentrating every possible shipbuilding resource upon the construction of a destroyer fleet that will be larger than that of any other naval power.

An important question involved in this immediate expansion of shipbuilding resources is the ultimate ownership of the new yards. While the Government would own them for the duration of the war, it is uncertain whether private shipbuilders could keep them in operation after the destroyer fleet is completed.

Lake Washington Canal Formally Opened

Vast opportunities for industrial development and commercial expansion were made available for the business interests in Seattle, Wash., at the formal opening on July 4 of the Lake Washington Canal, which connects Lake Washington with Lake Union and Puget Sound. The event was marked by a marine pageant in which several thousand vessels of all classes participated, the pageant being headed by the historical polar ship *Roosevelt*, which carried Rear Admiral Robert E. Peary on his North Pole expedition.

The canal is about 8 miles in length from Puget Sound to Lake Washington, and by its completion more than 60 miles of additional water frontage are given to Seattle, thus enabling ocean-going shipping to make use of the non-tidal fresh water basins of Lake Union and Lake Washington. Besides being of benefit for commercial purposes forethought has been given to the advantages of this project for naval purposes. As the water in Lakes Washington and Union never freezes, a splendid winter anchorage is available for vessels which are generally laid up for the winter months for fitting out and overhaul.

The locks of the canal, which were opened twelve months ago, and which were described in our September, 1916, issue, are second in size only to those of the Panama Canal. The main lock, which can accommodate any ship now afloat on the Pacific, is 825 feet long, 80 feet wide and 50 feet deep. The auxiliary lock is 150 feet long, 30 feet wide and 30 feet deep. Although the construction of the canal was suggested sixty-four years ago, it was not until 1911 that actual work on the project was begun. The total cost of construction was about $5,000,000.

Bowles and Snow Appointed Assistants to General Manager of Emergency Fleet Corporation

Rear Admiral F. T. Bowles, U. S. N., retired, and Naval Constructor Elliot Snow, U. S. N., have been appointed special assistants to Rear Admiral Capps, U. S. N., general manager of the United States Shipping Board Emergency Fleet Corporation.

Rear Admiral Bowles was Rear Admiral Capps' predecessor as chief constructor of the United States Navy, and after his retirement from the navy he was for several years president of the Fore River Shipbuilding Company. Naval Constructor Snow has been in charge of naval construction at the League Island Navy Yard, Philadelphia.

British Shipping Losses Dwindle to 320,000 Tons in July

Premier Lloyd George, speaking in the House of Commons on August 16, stated that during the month of July only 320,000 gross tons of shipping were lost through German submarines, and that during this month there was a substantial improvement over July.

Although 560,000 gross tons of shipping were lost in April the net losses since the commencement of Germany's unrestricted submarine warfare has been under 250,000 tons a month.

Premier Lloyd George also said that in the first six months of this year the new tonnage built in Great Britain was 484,000, while in the last six months, including purchases, the new tonnage would amount to 1,424,000. A considerable addition has also been made in the programme of naval construction. With the co-operation of America, the Premier said there would be sufficient tonnage for all of 1918, and, if necessary, for 1919.

SHIPPING BOARD PLANS TO BUILD 1,270 VESSELS

Programme Calls for Nearly 8,000,000 Tons of Merchant Shipping

Additional Appropriation of $1,134,000,000 Required

According to a statement recently submitted to the Secretary of the Treasury for transmission to Congress, relative to the Government merchant shipbuilding programme, the United States Shipping Board asks for an additional appropriation of $1,134,000,000. Of this amount it is estimated that $719,000,000 will be required for contracts for steel and wooden vessels; the sum of $265,000,000 will be required for commandeering ships at sea, and the remaining $150,000,000 will be used in moving available tonnage from the Great Lakes to the seaboard.

The building programme is as follows:

BUILDING PROGRAMME

	Number	Tonnage	Estimated Cost
Ships contracted for	433	1,919,200	$285,000,000
Ships ready to be contracted for when funds are available	452	2,968,000	455,500,000
Ships under negotiations	237	1,281,400	194,000,000
			$934,500,000
Miscel'n'ous vessels	150	1,800,000	300,000,000
Organization and other miscellaneous expenses			35,000,000
Amount authorized by Congress June 6, 1917 ($300,000,000 appropriated)			550,000,000
Amount to be authorized for building programme immediately in sight, making no allowance for changes in cost of labor and material			719,500,000

COMMANDEERING PROGRAMME

For commandeered ships, amount required	515,000,000
For commandeered ships, amount authorized by Congress June 6, 1917	250,000,000
Balance requiring authorization by Congress	$265,000,000

PURCHASE PROGRAMME

For vessels to be purchased other than under construction or commandeered	150,000,000

SUMMARY

Total amount, in round figures, to be purchased in addition to amounts already authorized:	
For commandeered vessels	265,000,000
For construction of new vessels	719,500,000
For purchase of new vessels	150,000,000
Grand total	$1,134,500,000
Amounts desired to be appropriated for remainder of fiscal year 1918:	
For commandeered vessels	$365,000,000
For building programme	400,000,000
For purchase of vessels	150,000,000
Total	$915,000,000

United States Steel Corporation Begins Construction of Large Shipyard in New Jersey

Erection of the large shipyard of the Federal Shipbuilding Company, which was organized and financed by the United States Steel Corporation, is now under way on the Hackensack Meadows, near Newark, N. J., and it is expected that the first two vessels will be launched on April 1, 1918, and completed on June 1, 1918.

Ten shipways, each about 500 feet long, will be provided, as well as a complete equipment, including a plate shop 165 by 800 feet, with a mold loft 126 by 800 feet on the second floor; a machine shop 125 by 150 feet, boiler shop 160 by 500 feet, forge shop 150 by 300 feet, rigging loft 50 by 150 feet, brass and iron foundry 100 by 300 feet, copper and tinsmithing shop 50 by 150 feet (two stories), joiner and carpenter shop 100 by 150 feet (two stories), power house 100 by 200 feet, main storehouse 50 by 150 feet (two stories), two branch storehouses, each 20 by 50 feet (two stories), and a main office building 70 by 500 feet (two stories).

The shipways are being constructed by the Fraser, Brace Company, New York; the shop buildings, which are of steel framework, with glass, iron and terra cotta sides, covered with stucco, by Post & McCord, Inc., New York, and the structural steel, 10,000 tons in all, is being furnished by the American Bridge Company.

Power for the plant will be supplied by the Public Service, Newark, and all machinery will be electrically driven.

The directors of the Federal Shipbuilding Company are E. H. Gary, James A. Farrell, Joshua Hatfield, Robert MacGregor, Richard Trimble, August Ziesing and W. J. Filbert. E. H. Gary is president; Richard Trimble, treasurer, and W. J. Filbert, secretary. Robert MacGregor is vice-president and general manager.

Wages and Working Conditions for U. S. Seamen

The Department of Commerce authorizes the following:

An agreement has been reached concerning wages and working conditions for men to man the merchant fleets of the country, and it is believed that the agreement renders easy the task of obtaining sufficient qualified men to operate the large number of merchant vessels now building.

The Wage Scale

The wage scale, which will remain in force until a year after the war ends, is as follows: Sailors and firemen, $60 per month; coal passers, $50 per month; oilers and water tenders, $65; boatswains, $70; carpenters, $75. Overtime pay for cargo work is figured at 50 cents an hour, and for ship work 40 cents an hour. A 50 percent bonus is to be paid crews entering the war zone. Employers will pay each seaman $100 compensation for loss of personal effects when a ship is sunk. The scale of wages and bonus for stewards and cooks is unchanged at present.

In order to increase the number of men available for work, each ship will carry a certain number of boys in proportion to number of seamen carried. The number of able-bodied seamen will be reduced; the deficiency will be made up by employing more ordinary seamen. Representatives of the seamen's organizations will be given access to docks and decks.

Termination of Agreement

The committee agrees that bonus and other conditions arising from the war shall terminate with the war, but the wage scale named above shall remain in force for a year after the war terminates. Employers and seamen will unite in an appeal to men who have left the sea to return, and to young men to go to sea as a profession.

The Provost Marshal General's Office will be requested to exempt seamen from military service wherever it can be done, on the ground that the scarcity of sailors makes them more valuable in that capacity than as soldiers.

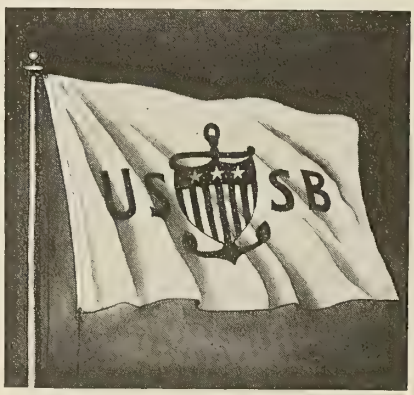
NEW OFFICERS OF UNITED STATES SHIPPING BOARD

E. N. Hurley, Chairman United States Shipping Board

Rear Admiral W. I. Capps, General Manager Emergency Fleet Corporation

Shipping Board's New Flag

In a few weeks there will begin to appear in the Seven Seas a new flag, symbolizing the return of the United States in all its power to fellowship with the leading maritime nations of the earth.



Official Flag of United States Shipping Board

The new standard is the recently-adopted official flag of the United States Shipping Board, and it will fly over all the ships under the Board's control, which will comprise the largest fleet of merchant vessels ever commissioned under one management.

The flag consists of a white ground on which is displayed the National shield in full colors of red, white and blue, supported by a blue anchor, and flanked on the left by the letters "U. S." and on the right "S. B." The proportions of the flag, in the size to be flown by a ship of 8,000 tons, are 6 feet hoist to 9 feet length.

Steamer Eastland to Become U. S. Gunboat

The steamer *Eastland,* which turned over in the Chicago River two years ago, causing the death of more than 800 excursionists, is practically ready for service as a gunboat of the United States Navy.

The steamer has been rebuilt and cut down so that it will be more seaworthy and will be able to steam about 22 knots. She will carry four 3-inch guns and four 3-pounders, and will probably be used as a training ship on the Great Lakes.

Vessels Should Carry Supplies for Round Trip

To assist the allies in conserving foodstuffs and other necessities, Secretary Redfield, at the request of Secretary Daniels, has issued the following important announcement to owners of American merchant vessels engaged in over-seas trade:

Owing to the present shortage of provisions, supplies and stores abroad, all merchant vessels sailing from United States ports for a round trip to any of the belligerent countries should provide themselves so far as practicable with all necessary stores, provisions and fuel for the round trip.

S. S. *Frances L. Skinner*, Formerly the Kosmos Liner *Sesostris*

New Orleans Designated by Shipping Board as Headquarters for Recruiting From Gulf States

Official announcement is made in New Orleans on behalf of the United States Shipping Board that that city has been named by the Board as headquarters for its recruiting service for the Gulf States.

Ernest Lee Jahncke has accepted an appointment from the Shipping Board to act as its representative in the territory.

Philadelphia School Begins Training Marine Engineers

The Philadelphia branch of the United States Marine Engineering School, which opened on August 20, will be the largest in the country. Unlike the other branch schools, it will be the only one with a boat for practical instruction. This feature already has attracted more students for the first term than all other Federal marine engineering schools combined.

Smoke Boxes for Protection of Ships Obtainable

The Bureau of Ordnance of the Navy Department is having manufactured by the Du Pont Company smoke boxes suitable for use by merchant vessels as a means of escape from attacking submarines. The cost will be approximately as follows: Smoke funnel, $125 each; phosphorus, $1.75 per pound; smoke boxes, $25 each.

The smoke funnel is for the production of smoke on board the vessel and requires only the fuel for its continued use. The smoke boxes are for throwing overboard and once used cannot be recovered.

The Navy Department is preparing to issue smoke boxes to all vessels carrying armed guards, and has announced as its policy that smoke-producing apparatus for the use of merchant vessels should be available for every vessel desiring to purchase same. It is urged that merchant vessels give prompt and favorable consideration to the desirableness of purchasing smoke-producing apparatus.

S. S. Frances L. Skinner Sails on Oriental Voyage

On July 18, the *Frances L. Skinner*, formerly the *Sesostris*, the salvaging of which, after lying for ten years on the beach at Ocos, Guatemala, was described in our last issue, left the dock at the Skinner & Eddy Shipbuilding plant, Seattle, Wash., and sailed for Tacoma, where a load of 3,000 tons was taken on board, after which she returned to Seattle to complete her cargo, destined for Oriental ports.

The ship, after having been salvaged by the Skinner Syndicate of Seattle, and brought up the coast under her own steam, was completely remodeled at the Skinner & Eddy plant, practically all the superstructure having been replaced and the entire fittings throughout standardized and brought up to date. The contrast between "the old and the new" can readily be seen by comparing the photograph of the vessel reproduced herewith with those which were published in our August issue.

Lloyd's highest rating has been granted the vessel, and, in addition, her former freeboard has been reduced, giving her a greater deadweight carrying capacity. It is claimed by many who inspected the vessel that when many of the steel ships building to-day retire to the graveyard, the *Frances L. Skinner* will still be afloat in fine condition, due to the fact that the scantlings throughout are of greater dimensions than required by Lloyd's to-day, and that these have not been diminished by disintegration during the long period when the vessel was stranded on the Mexican coast. This latter fact can be ascribed in part to the high quality of steel which was used in the construction, and also to the superior workmanship, of which her builders can well be proud.

SHIPYARD EXTENSIONS AND CHANGES

Consolidations, Sales and Improvements

B. B. Crowninshield, 75 State street, Boston, Mass., W. A. Swasey and associates have incorporated the Crowninshield-Swasey Shipbuilding Company at Fall River, Mass., and have purchased Read Bros.' shipbuilding plant at Somerset, Mass.

The Atlantic Coast Company, a newly-organized corporation, has bought the shipyard of the Townsend Marine Railway & Construction Company, Boothbay Harbor, Me.

The Oregon Shipbuilding Company and the Motorship Construction Company, both of Portland, Ore., have been consolidated, and the latter company's plant at Vancouver will be enlarged. These two concerns are reported to have contracts to build 160 lifeboats.

The Goodrich Transit Company, Chicago, Ill., is planning to spend a large sum of money building repair yards, machine shops, etc.

The Staten Island Shipbuilding Company, Port Richmond, S. I., has awarded a contract to John Miles & Company, Port Richmond, to build a machine shop, blacksmith shop and boiler works.

The construction of 26 new ship ways on the Delaware River has been undertaken by the Traylor Shipbuilding Corporation, whose head office is at present in Allentown, Pa., and by the Chester Shipbuilding Company, Chester, Pa.

L. H. Gray, formerly vice-president of the Anderson Shipbuilding Corporation, Seattle, Wash., has severed his connection with that company and will build another shipbuilding plant at Seattle.

Griswold, O'Donnell Company, Portland, Ore., plans to erect a wooden shipbuilding plant on the waterfront at Vancouver.

The Sandy Point Shipbuilding Corporation, New York, has acquired land and wharf rights at Stockton Springs for establishing a shipyard.

Government Steamer *Surveyor*, Designed for Long Cruises in Alaskan Waters

New Coast and Geodetic Survey Steamer

The *Surveyor*, an all-steel vessel of 1,000 tons displacement, designed for work as an off-shore surveying ship in the North Pacific, and particularly off the coast of Alaska, has recently been completed for the United States Coast and Geodetic Survey. She is 183 feet long, with 34 feet beam and 12 feet loaded draft. Power is furnished by a single triple-expansion steam engine of 1,000 horsepower. Oil is used as fuel in the boilers.

The *Surveyor* has a storage capacity for 75,000 gallons—enough to carry her 5,000 miles at full speed, or 7,500 miles at working speed.

The vessel is equipped with water tanks and storerooms sufficient for a period of six months, and is designed to keep the sea without making port for several months at a time.

Output of World's Shipyards

New merchant ship tonnage, built during the six months from October, 1916, to April, 1917, amounted to 728 ships of 1,667,524 gross tons, according to figures recently published by the Bureau Veritas. The output in the various maritime countries was as follows:

	Number of Ships	Gross Tonnage
Great Britain	261	680,946
United States	150	484,381
Holland	103	190,619
Japan	46	128,913
France	42	61,988
Italy	20	34,051
Norway	42	34,044
Denmark	20	26,348
Sweden	26	20,023
Spain	7	4,422
Chili	3	823
Russia	5	750
Portugal	3	216
Total	728	1,667,524

Owing to the present increase in shipbuilding in both the United States and Great Britain, these figures will obviously be greatly exceeded at the end of the next six months.

SHIPBUILDING COMPANIES INCORPORATED OR PROJECTED

The Supple-Ballin Shipbuilding Company, Portland, Ore., has been incorporated by James Supple, F. A. Ballin and others.

The Coos Bay Shipbuilding Company, Marshfield, Ore., is planning the construction of a shipyard at Marshfield.

The Midland Bridge Company, Kansas City, Mo., announces that it will build a shipyard at Houston, Tex.

The Florida Marine Construction Company has been organized at Jacksonville, Fla.

The American Shipbuilding Corporation has been organized at Beaumont, S. C. R. C. Horne, Jr., and W. E. Richardson are among the incorporators.

The Fay Shipbuilding Company will build a shipyard at Eureka, Cal.

The Merchants Marine Construction Company, Los Angeles, Cal., is planning the construction of a shipbuilding plant at Long Beach.

Oscar E. Jackson, of Duncan, Jackson & Duncan, 79 Wall street, New York, has organized a company with the intention of building a shipyard on Staten Island.

The American Cement Ship Company has been organized in Boston, Mass. The president is H. W. Loker, Boston.

The Dauntless Shipyard, Inc., has been organized at Essex, Conn., by Chas. A. Goodwin and others.

Charles Hall, North Bend, Ore., is at the head of a company which is planning the construction of a shipbuilding plant at North Bend.

The Union Construction Company, Oakland, Cal., is planning to build a shipyard at Oakland.

The Mann Shipbuilding Company has been incorporated and is planning the construction of a plant on Curtis Bay, near Baltimore. W. W. Mann is president.

The Henderson Shipbuilding Company has been organized in Mobile, Ala. Frank Henderson is president; W. T. Henderson, vice-president and treasurer, both of Mobile.

The North Carolina Shipbuilding Company announces that it will build a shipyard at Morehead City, N. C.

Poage & Company, Tampa, Fla., are planning a yard at Tampa, with the intention of building wooden ships.

The Ohio Shipbuilding Company has been incorporated, with headquarters in Cleveland.

The Griswold-O'Donnell Company, Portland, Ore., is planning the construction of a shipbuilding plant at Vancouver, Wash.

The Fernandina Shipbuilding & Dry Dock Company has been organized at Fernandina, Fla.

J. F. Warren, secretary of the Apalachicola, Fla., Chamber of Commerce, states that a shipbuilding corporation has just been organized in his city, and that the construction of a yard will be begun at once.

The Elizabeth City Shipyard Company has been incorporated with headquarters at Elizabeth City, N. C. R. B. Cotter is president, J. Ehringhaus, vice-president.

The Boothbay Harbor Shipbuilding Company has been incorporated by Mayor Cliff, of Somerville, Mass., and associates.

The Bagdad Shipbuilding Company has been incorporated, with headquarat Pensacola, Fla., yard at Bagdad. J. A. Merritt is president; R. W. Turner, secretary, both of Pensacola.

The Hodge Ship Company has been incorporated. O. E. Hodge is president; J. S. Hunt, vice-president, both of Hodge, La.

The Diercks-Blodgett Shipbuilding Company has been incorporated by D. V. Diercks, J. B. Kirkpatrick and others, of Kansas City, Mo. The company will build a shipyard on the Pascagoula River, Miss.

The Tregoning Boat Company, Seattle, Wash., Frank C. Tregoning, president, is planning the construction of a shipbuilding plant at Portland, Ore.

SHIPBUILDING CONTRACTS

Recent Orders for Merchant and Naval Vessels

The Foundation Company, 233 Broadway, New York, which is building shipyards in various parts of the country, is reported to have received contracts from the French Government to build forty sailing vessels.

The Columbia River Shipbuilding Corporation, Portland, Ore., is reported to have received contracts to build several steel vessels for the French Government.

The Gulfport Shipbuilding Company, Gulfport, Miss., is reported to have received a contract to build five steamers.

The contract of the Kelly-Atkinson Construction Company, Chicago, Ill., with the United States Emergency Fleet Corporation, is said to call for 18 composite steamers, and to include all the machinery. The Kelly-Atkinson Construction Company has purchased 16 acres on the Mobile River, Mobile, Ala., and has already started work on its shipyard.

J. F. Duthie & Company, Seattle, Wash., are reported to have received a contract from the French Government to build two 8,800-ton steel steamers.

The contract of the Hollywood Shipbuilding Company, Oakland, Cal., with the United States Emergency Fleet Corporation is said to call for six 8,800-ton steel steamships.

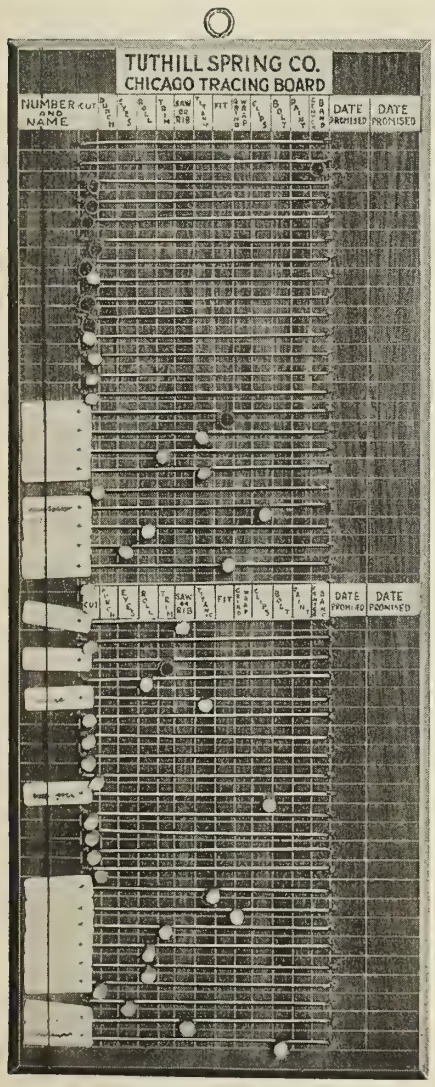
The Elliott Bay Shipbuilding Company, Seattle, Wash., is reported to have received contracts to build four auxiliary schooners.

The Portland Shipbuilding Company, Portland, Me., has received a contract from the East Coast Fisheries Company to build two steam trawlers.

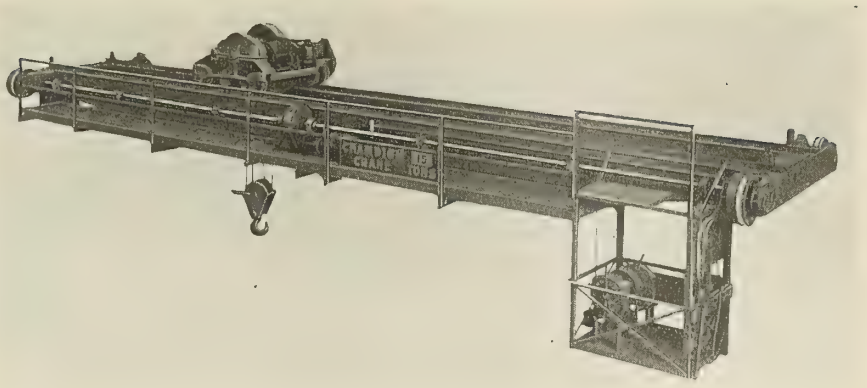
Keeping Track of Orders with a Tracing Board

Keeping tabs on orders so that delays are noticed, the causes discovered, and deliveries made on schedule time, is a problem common with all manufacturers. The Tuthill Spring Company, of Chicago, formerly kept track of the progress of orders through their plant by a card index system. Each day the exact location of each job was noted on a card, and the superintendent or shipping clerk was able to keep posted on just what was taking place by fingering through the cards.

However, an engineer of the Tuthill Spring Company, Mr. Harold T. Moore, trained in working out short manufacturing cuts, devised a better way. The tracing board shown in the picture is the result. The one illustrated is used in tracing Chicago orders. Each day the entry clerk, in much shorter time than it took to make the card records, can bring his tracing board up to date. The merest glance tells the superintendent, or anyone else interested, the exact status of each job.



Tracing Board for Keeping Tabs on Progress of Work in the Shops



Champion Electrical Traveling Crane

How Fabrikoid Is Made

Owing to the scarcity of leather, Fabrikoid, which is manufactured by the E. I. Du Pont de Nemours & Company, Wilmington, Del., has been adopted by the Government as its standard for ship upholstery. Its base is a specially woven fabric of cotton, so designed as to the number and size of the threads in the warp and woof that the finished material will have at least twice the tensile strength of split leather.

After the cotton cloth is carefully examined by experts to guarantee its quality and strength, it is run through die vats, where the material is shrunk, so that the completed product can be depended on not to stretch or sag. After drying, the fabric is ready for the special processes by which is obtained the soft leather-like feel of fabric, the machinery used being especially designed for the purpose. The fabric is then run through coating machines, where it is coated with Pyroxylin solutions. After receiving the coating, which gives the fabric a tough wear-resisting surface, the fabric is passed through embossing machines, where it is made exactly to represent natural leather. Fabrikoid is furnished in about sixty different grains, and the finished material is thoroughly inspected before shipment.

The base of the coating solutions used is raw cotton, which is nitrated and then dissolved in various solvents. The Du Pont Fabrikoid Company, it is claimed, are the only manufacturers in America who nitrate their own cotton, dissolve it in their own solvents, and, to a large extent, make their own coloring pigments. This gives the company a chemical as well as a mechanical control of the entire system of production.

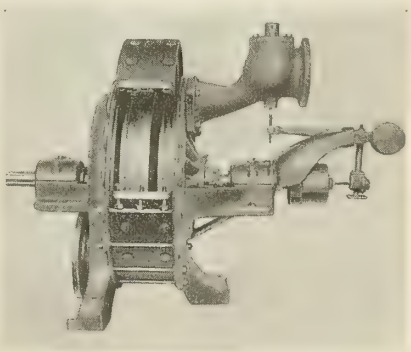
Traveling Shop Cranes Built by the Biggs-Watterson Co.

With a view to meeting the most severe requirements usually called for by shop crane specifications, and at the same time producing a machine from the standpoint of high efficiency, the Biggs-Watterson Company, Cleveland, Ohio, has placed on the market the Champion Crane, which has a capacity of 15 tons. As shown by the illustration, the main frame of the crane is composed of two box-section steel girders, thoroughly braced with heavy gusset plates to prevent twisting of the structure, and fitted with special trucks at each end. On this bridge-like structure the operating trolley containing the lifting mechanism travels. Separate motors operate the trolley and bridge, all operated by controllers in an operator's cage at the end of the crane.

Curtis Steam Turbines for Fans, Blowers and Pumps

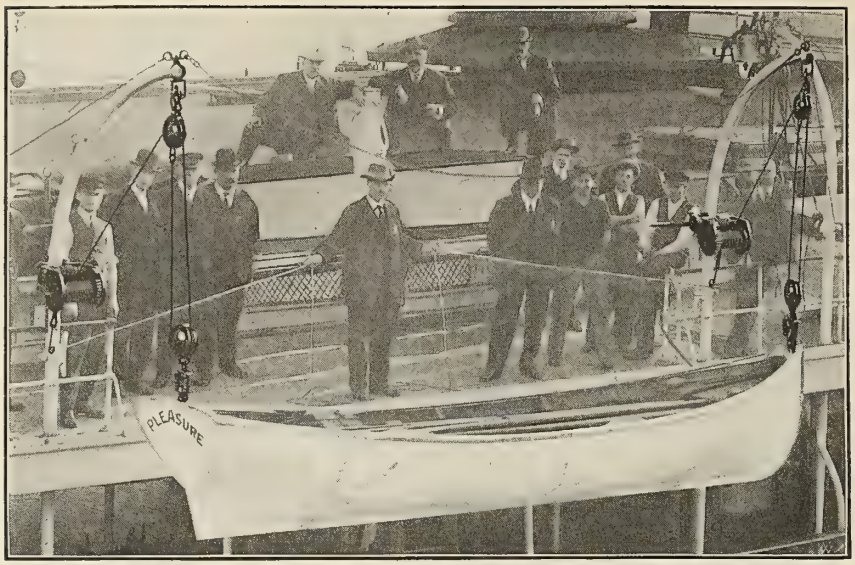
The General Electric Company, Schenectady, N. Y., has developed a Curtis steam turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems. It is called the Type L, and is of the impulse type. The number of stages and rows of buckets vary with the capacity.

A split wheel casing is used to permit ready inspection of the buckets, which are of bronze securely dovetailed into the rim of the wheel. The exhaust steam is free from oil and is well suited for heating feed water.



Type L, Curtis Turbine

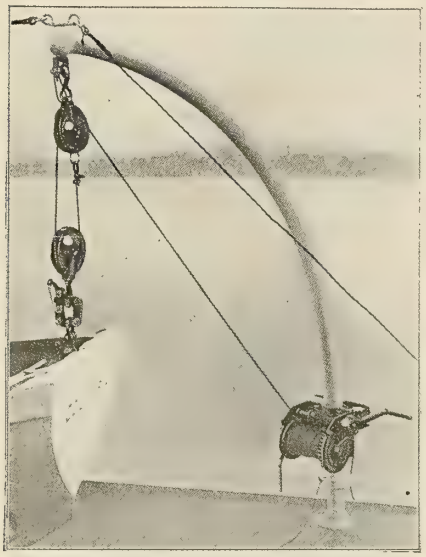
Speed regulation is close and reliable, and the speed may be changed by handwheel adjustment while the turbine is in operation. A constant running speed is maintained by a simple and powerful speed governor mounted directly on the shaft and controlling a double-balanced piston valve type throttle.



One Man Lowering Lifeboat with J-H Windlass and Releasing Hooks

J-H Lifeboat Windlasses and Rapid Releasing Hooks

The Eckliff Circulator Company, Detroit, Mich., has placed on the market a new line of equipment for handling lifeboats on board ship. The object sought is to secure safe and speedy raising, lowering and releasing of lifeboats. The apparatus is so constructed that the lowering mechanism can be controlled by one line in the hands of one man. One



J-H Windlass Mounted on Davit

windlass, which can be bolted to the deck or to the davit, will handle each lifeboat. Steel cables only are used.

In numerous demonstrations a twenty-six-person lifeboat has been swung out and lowered to the water, a distance of 38 feet, with the J-H windlass by two men in twenty seconds. As a matter of fact, one man can control the lowering of the boat, and should he be disabled and drop the controlling line no harm will result, as an automatic governor positively prevents a too-rapid fall.

The releasing hook is so constructed that when the hook is closed the tumbler engages an upper cross arm of the frame in such a manner as to securely lock the hook in the closed position. It is claimed that it is impossible for these interlocking parts to become disengaged until the releasing lever is lowered from the upright position. Instant and simultaneous release of the hooks at both ends of the boat is accomplished by means of a releasing mechanism from which a cable runs to the lever of each hook. Tension is applied to both cables simultaneously, so that both hooks open at the same instant.

Bonus for Galveston Shipbuilders

The Galveston Commercial Association is endeavoring to raise a fund of $100,000 with which to pay bonuses of 2 percent to shipbuilding companies for each ship built at Galveston costing not less than $300,000.

Twenty-Thousand-Ton Floating Dry Dock Being Installed at Sparrows Point

The Bethlehem Steel Corporation is installing at its Maryland shipbuilding plant, Sparrows Point, Md. (formerly Marine Department, Maryland Steel Company), a floating dry dock of 20,000 tons lifting capacity, designed by William T. Donnelly, naval architect and consulting engineer, New York.

The pontoons of the dock are of wood, and contain 4,000,000 feet of yellow pine. The side walls or wings are of steel, 3,000 tons of steel being required for their construction.

Shipping Valued at $8,000,000 Will Be Built in Maine

The Maine Shipbuilding Committee, appointed several months ago by Governor Milliken, to arrange for the construction of wooden ships in Maine as a part of the national shipbuilding programme, announced on August 10 that shipping valued at $8,000,000 will be built in Maine. Each of the vessels will cost about $300,000 without machinery. Ships valued at $1,500,000 are already under construction in various Maine shipyards.

All Merchant Ships to Be Armed by the Government

That the Government intends to push the work of arming all merchant vessels was indicated by a recent announcement of an order given to the Wagner Electric Company, St. Louis, Mo., for the manufacture of 1,000 4-inch guns to cost $6,000,000. These guns will be used solely, it is understood, for arming merchant vessels and army transports.

Five-Thousand-Ton Concrete Ship Now Being Built in San Francisco

The San Francisco Shipbuilding Company, through McDonald & Kahn, concrete contractors, designers and builders, and Calvery & Garden, consulting marine engineers, are building a concrete ship 320 feet long, 44 feet beam and 32 feet deep, of 5,000 tons, on San Francisco Bay. The estimated cost of the vessel is $350,000. Before the propelling machinery is installed the hull will be towed to Seattle in order to test its strength at sea.

National Shipbuilders' Association Formed

The National Shipbuilders' Association was organized in Washington on August 11, as a result of an extended discussion among representatives of private shipbuilding companies as to the means whereby the interests of the several companies as well as the interests of the Government could be best fostered.

It is believed that the association will not only save time to the shipbuilders, but that it will also obviate the necessity of unnecessarily utilizing the valuable time of the members of the Shipping Board. It will insure closer touch with the Shipping Board and Emergency Fleet Corporation by having innumerable questions, which are bound to arise, handled collectively rather than individually.

No fees will be charged to the members of the association, and the assessments will be confined to the actual expenses for the maintenance of the association's headquarters in Washington.

Naval Training Schools

A training school at Newport, R. I., to fit members of the Naval Reserve for commissions in the Navy, will be opened by the Navy Department at the Cloyne school house. A course of four months will be given.

Through the Division of Naval Militia Affairs the Navy Department has approved of another Federal training station for the naval militiamen to be located at Rochester, N. Y. This station occupies the armory of the Third Battalion, located on Lake Ontario.

The North Carolina Shipbuilding Company at Morehead City, capitalized at $200,000, under the laws of North Carolina, has received a contract for two vessels from the United States Shipping Board.

Pacific Coast Port Authorities to Hold Convention

The Pacific Coast Association of Port Authorities will hold its annual meeting at Portland, Ore., September 4, 5 and 6. Charles B. Moores, Portland, chairman of the Commission of Public Docks, is president, and G. B. Hegardt, engineer for the Portland Commission, is secretary.

American Shipbuilding Company's Profits Increase

The annual report of the American Shipbuilding Company, Cleveland, Ohio, shows net profits for the fiscal year ended June 30, 1917, of $3,148,040, after deducting $400,000 from net earnings for an estimated six months' excess profits tax. This is equal to $34 a share on the common stock after allowing 7 percent for the preferred.

Shipbuilding Contracts

The J. H. Mendell Engineering Company, Manchester, N. H., has received a contract for the construction of thirty wooden ships from the United States Shipping Board. This company will build a large shipyard on the Piscataqua River at Newington, near Portsmouth, N. H. Over 3,000 men will be employed at this yard.

A new shipbuilding company, which is reported to have orders for twelve steel steamships with a capacity of 9,500 tons each, will be located at Brunswick, Ga.

A shipbuilding concern, of which Charles Bright, South American railroad builder, is the head, has acquired waterfront rights at Sandusky, Ohio, for a large shipbuilding plant. The company, it is announced, has a contract for building $5,000,000 worth of small boats for the Government.

Chester Shipbuilding Company Reorganized

A reorganization of the Chester Shipbuilding Company, Inc., Philadelphia, has been announced. Hereafter the Chester Shipbuilding Company will control only the shipbuilding plant at Chester, Pa., and the plant recently acquired at Bristol, Pa., will be under the control of the Merchants' Shipbuilding Corporation, which was recently incorporated by Arthur P. McKinstry, a lawyer, 60 Wall street. Officers for the Merchants' Shipbuilding Corporation and the Chester Shipbuilding Company are the same, and have elected as follows: Chairman of the board of directors, W. A. Harriman; president, R. H. M. Robinson; vice-president and comptroller, C. B. Seger, all of 165 Broadway, New York; vice-president, Carl W. Hamilton; secretary and treasurer, William M. Simpson, both of 50 Broad street, New York; general manager, W. T. Smith; consulting engineer, C. P. M. Jack; engineering manager, Max Willemstyn, all of Finance building, Philadelphia.

The Merchants' Shipbuilding Corporation has obtained a contract from the Emergency Fleet Corporation to build twenty or more steel cargo-carrying steamers. The Chester Shipbuilding Company is reported to have received a similar contract.

Noted Naval Architect Dies

Washington Irving Babcock, head of the firm of Babcock & Penton, naval architects, New York, and son of the late Capt. David S. Babcock, died at his home in New York on August 7, aged 59.

Mr. Babcock was one of the best known naval architects in the United States, having been associated for years with prominent developments in shipbuilding on the Great Lakes and the Atlantic coast. His father, Capt. David S. Babcock, was president of the Providence & Stonington Steamship Company, and his son, who had been educated at the Rensselaer Polytechnic Institute, Troy, N. Y., and served his apprenticeship with John Roach & Son, Chester, Pa., and at the Morgan Iron Works, New York, was appointed assistant to the president of the Providence & Stonington Steamship Company at the time of his father's death.

In 1887 Mr. Babcock became manager of the Union Dry Dock Company, Buffalo, N. Y., and two years later he organized the Chicago Shipbuilding Company, of which he became general manager and vice-president and later on president. For years this yard was the most important shipbuilding plant on the Great Lakes. Finally, in 1889, it was absorbed by the American Shipbuilding Company, after which Mr. Babcock became established in New York as a consulting engineer and naval architect.

W. I. Babcock

In 1907, H. Penton, naval architect, Cleveland, Ohio, became associated with Mr. Babcock, under the firm name of Babcock & Penton. Mr. Penton had formerly been associated with Mr. Babcock as chief engineer of the Chicago Shipbuilding Company, and later as chief engineer of the Great Lakes Engineering Works. The firm will be continued under its present name.

Mr. Babcock was a vice-president and member of council of the Society of Naval Architects and Marine Engineers, and also a member of the American Society of Naval Engineers, Institution of Naval Architects (Great Britain), and a member of the Engineers' Club, New York. Mr. Babcock was a pioneer in several lines of development in shipbuilding, especially on the Great Lakes. He was an early advocate on the lakes of the modern type of bulk freighter. He designed and built the first 400-foot lake bulk freighters, and was also the designer of the first electrically-propelled and controlled boats, these being the Chicago fire boats. The firm of Babcock & Penton was also responsible for the development of the self-unloading type of ship which is now extensively used on the Great Lakes.

Personal

Charles L. Reed, formerly with the Maryland shipyard of the Bethlehem Steel Corporation, has taken charge of all the steel work at the Todd yards, Tacoma, Wash., as superintendent of hull construction.

M. A. Neeland has been elected president of the New York Shipbuilding Corporation, Camden, N. J., succeeding S. M. Knox, who has been elected chairman of the board of directors. George J. Baldwin, former chairman of the board, has been elected chairman of the executive committee, which has been increased from three to five members.

A. E. Martell, formerly chief engineer of the oil engine department of the Southwark Foundry & Machine Company, Philadelphia, Pa., builders of the Southwark-Harris Diesel type oil engine, is now associated with Leonard B. Harris, consulting engineer and naval architect and inventor of the Southwark-Harris oil engine, with offices at 411 Walnut street, Philadelphia.

S. Culyer Jenkins has recently been appointed assistant general manager of the Slidell Shipbuilding Company, Inc., Slidell, La. Mr. Jenkins was connected with the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for a number of years, and was later appointed marine designer of the Panama Canal.

Raymond E. Lovekin, managing director of the American Screw Propeller Company, Philadelphia, Pa., recently returned from an extended visit to the shipyards on the Pacific Coast, where he was successful in securing large contracts from the principal shipbuilders and shipowners on the Coast.

E. C. Bennett, formerly naval architect of the Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed vice-president and general manager of the Newburgh Shipyards, Inc., Newburgh, N. Y.

W. H. Benson has been appointed superintendent of hull construction of the Fore River Shipbuilding Corporation, Quincy, Mass.

William J. Deed, of Boston, Mass., naval architect and power boat specialist, has been appointed consulting naval architect in the shipbuilding department of the American Shipping & Export Company, 112 Water street, Boston. This company recently purchased the shipyard of Thomas M. Fairchough & Company at Winthrop, Mass., and have under construction there, from Mr. Deed's designs and under his supervision, a fast patrol boat for John G. Quinby, Jr., of New York, which will go into naval service upon completion. The company is also negotiating for the purchase of other shipyards.

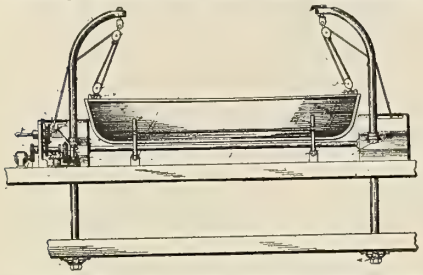
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,202,525. LAUNCHING APPARATUS. CHARLES HUNT, OF NEW YORK, N. Y.

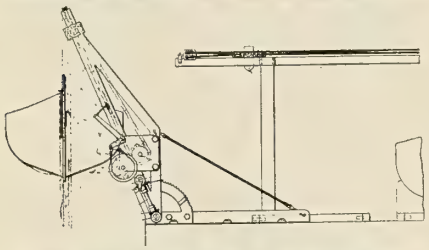
Claim 1.—A launching mechanism for boats having, in combination, davits and launching tackle for swinging the boat; a launching mechanism operatively connected to each davit includinug a train of gearing; and means for normally locking the same from operation in



one direction; means for releasing the gear to permit turning of the davits; means for breaking the train of gearing and simultaneously locking the same from turning; and means for controlling the boat while the same is being lowered. Eleven claims.

1,202,526. APPARATUS FOR LAUNCHING LIFE BOATS. ROBERT HUNTINGTON, OF MEDFORD, MASS.

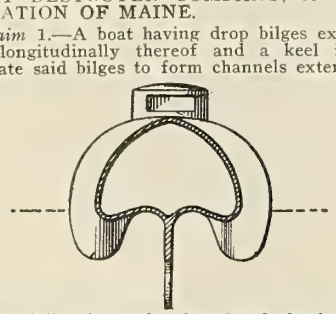
Claim 2.—In a device the combination with a vessel of two davits each presenting a forked lower end which is hinged to the vessel, a segmental gear fixed to the deck of the vessel and



situated between the arms of the fork of each davit, a gear journaled in the fork end of each davit and meshing with its segmental gear, means connecting said gears whereby both may be rotated in unison from a single point, thereby to swing both davits simultaneously inboard and outboard, and endless chain falls sustained by the davits. Five claims.

1,202,713. BOAT. EDWARD E. HEDGES, OF WELLESLEY HILLS, MASS., ASSIGNOR TO AMERICAN SUBMARINE BOAT DESTROYER COMPANY, A CORPORATION OF MAINE.

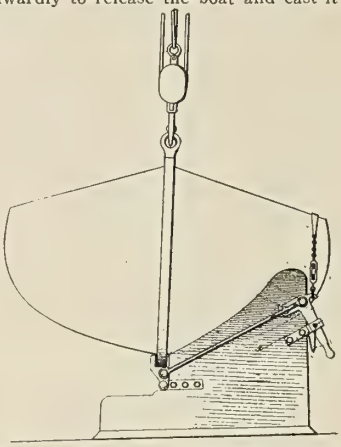
Claim 1.—A boat having drop bilges extending longitudinally thereof and a keel intermediate said bilges to form channels extending



substantially the entire length of the boat at the water line, said keel extending a material distance below said bilges throughout the length thereof and to the upper margin of said channels, said upper margin being designed to be substantially in a plane coincident with the surface of the water. Five claims.

1,202,998. CHOCK FOR LIFE AND OTHER BOATS. AMOS S. HEBBLE, OF EAST ORANGE, N. J.

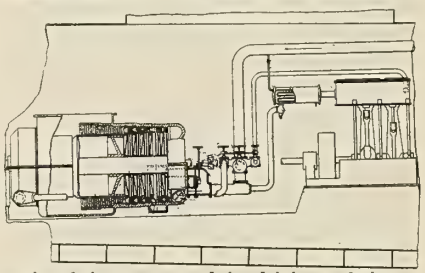
Claim 1.—A chock for boats comprising a rigid body secured to the deck of a boat and having an outboard surface to engage the boat at the inner side of the keel thereof, a member at the lower end of said body pivoted thereto and having a surface upon which the keel may rest and a jaw to extend along the outer side of said keel, an angular lever pivotally secured at the end of one arm thereof to the upper portion of said body and having its other arm exposed to serve as a handle for manual operation, a rod extending from the angle portion of said lever to said pivoted member of the chock, for turning said member outwardly and downwardly to release the boat and cast it out-



wardly from said body and throw its weight upon the cables and davits, and means for locking said lever in its restrained position holding said pivoted member against the said keel and in position to support the same. Six claims.

1,214,207. STEAM PROPULSION APPARATUS. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—The combination with a reciprocating engine, of a turbine, said turbine and

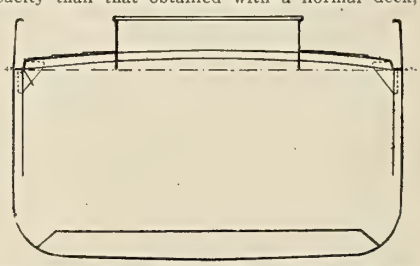


engine being connected in driving relation to the same shaft, said turbine having full power stages and auxiliary stages, means for supplying steam to said engine, and means for passing steam from the exhaust of said engine to the turbine and admitting it to either the full power or auxiliary stages. Thirteen claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

105,315. "IMPROVEMENTS IN DECKS FOR SHIPS." PER BJORN-ROLI, MECHANICAL ENGINEER, OF KIRKEGATAN 8, CHRISTIANIA, NORWAY.

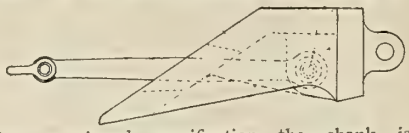
This invention has for its object such an arrangement as will secure a large cubic tonnage, greater draft and greater carrying capacity than that obtained with a normal deck,



but with otherwise equal dimensions of the hull. For this purpose the stringer plate is flanged (bent up) at the inner edge of the frame and above the beam, the height of which is increased and laid above the molded line instead of below the same. This arrangement may be used for the whole length of the ships or for part of the same, for instance, the well-deck of well-deck ships. By means of this arrangement the height of hold is augmented by the height of the beam, as compared with the hold of a normal ship.

105,183. "IMPROVEMENTS IN ANCHORS." J. B. RICHARDSON, OF MAESYFFYNNON, PONTYPRIDD, IN THE COUNTY OF GLAMORGAN, MANAGING DIRECTOR OF BROWN, LENOX & CO., LTD., OF PONTYPRIDD.

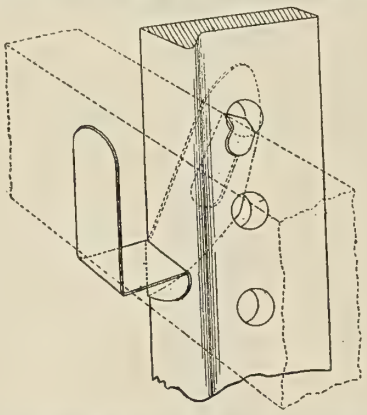
This invention relates to anchors of the type described in the specification No. 18,867, of 1901. In the type of anchor described in the



above-mentioned specification the shank is pivoted by means of a pin which passes through holes in two lugs carried by the anchor block. According to this invention, the lugs and webs are so placed that they take the pull of the shank in compression when the shank is in tension. Preferably, the webs extend to the top wall of the block.

103,954/16. "IMPROVEMENTS IN OR RELATING TO CLEATS OR BRACKETS FOR SHIPS' CARGO AND OTHER BATTENS, AND THE LIKE." D. J. GREEN, OF 61, QUEEN ALEXANDRA ROAD, NORTH SHIELDS, IN THE COUNTY OF NORTHUMBERLAND, SHIP DRAUGHTSMAN.

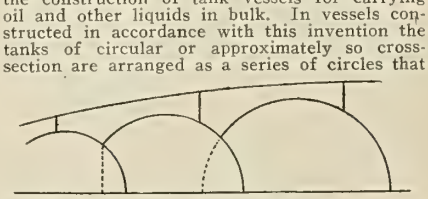
In this cleat or bracket the arm which lies edgewise relative to the arm that is bent to form a holder for the batten, has three sides



of a rectangle punched in it, or has a longitudinal slit, and the tongue thus formed bent laterally and downwardly to form an attacking hook, while the upper part of the said arm extends beyond the hook and is adapted to bear against one side of the rib, or support the depending part of the attaching hook bearing against the opposite side of the rib.

16,834/15. "IMPROVEMENTS IN THE CONSTRUCTION OF TANK VESSELS." J. W. ISHERWOOD, OF RAGGLESWOOD, CHISLEHURST, NAVAL ARCHITECT, AND J. W. STEWART, OF 21, HOLMWOOD GARDENS, CHURCH END, FINCHLEY, N., NAVAL ARCHITECT.

This invention relates to improvements in the construction of tank vessels for carrying oil and other liquids in bulk. In vessels constructed in accordance with this invention the tanks of circular or approximately so cross-section are arranged as a series of circles that



overlap or encroach upon each other in plan, or in other words, a portion of the wall of each tank is omitted, as seen in plan, to permit a portion of the wall of the adjoining tank to encroach on its interior, the tanks being efficiently attached to each other so as collectively to increase the longitudinal strength of the vessel.

105,189. "A SLIDING WATERPROOF HATCH FOR FREIGHT CARRYING CRAFT." H. FISHER, 6, WILSON STREET, PLAISTOW, ESSEX, WHARF FOREMAN.

The invention relates to improvements in flexible hatchways of the kind composed of thin connected metal plates adapted to be coiled upon drums, and adapted to be fitted to all freight-carrying craft as lighters, barges and canal-boats. The object is to provide a simple arrangement for maintaining such hatches in the position to which they have been opened by hand, and for draining the hatch coamings of all water or rain.

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More Liberty Bonds

THE campaign for the second liberty loan, which opens on October 1, will close on October 27. Practically everyone who participated in the first liberty loan should find it an easy matter to make a second subscription, as arrangements will be made so that payment for the bonds can be made from future savings. War savings certificates will be sold in as small denominations as $5 (£1).

Shipyard Strikes

THE differences between employers and employees in many of the shipyards, which have led to numerous strikes and consequent delays in shipbuilding, must give way to a working agreement on a basis which will be fair to both sides of the controversy. Although the causes of the labor disputes differ in many cases, nevertheless the commission which has been appointed by the President to visit the localities where disagreements have been most frequent should speedily clear up any misunderstandings which hitherto have prevented settlements.

War Committee of Technical Societies

A COMMITTEE has been organized by the Engineering Council, to be known as War Committee of Technical Societies. The function of this committee will be to act as the intermediary or means of communication when desired in matters relating to science, research, invention and engineering between the army and navy, the various boards, councils, committees and other agencies of the government and the membership of the societies represented for the purpose of presenting problems in science, research, invention and engineering to the members of the technical societies and of obtaining their ideas and suggestions.

It is hoped that in this way the large number of members of the technical societies who are not already actively at work on war problems can be reached, and their inventive, technical and engineering abilities mobilized. The societies represented on the War Committee include the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, the Mining and Metalurgical Society of America, the American Electro-Chemical Society and the American Institute of Electrical Engineers.

Use the Inland Waterways

IN an address delivered before the Business Men's War Convention at Atlantic City, Walter Parker, assistant to Secretary Redfield, of the Department of Commerce, made a strong appeal for a greater use of inland waterways to meet the transportation problems now facing the country. He pointed out that the inland navigable waterways of the United States must be used as an adjunct to the railroads and in co-ordination with the railroads. To meet the urgent needs, a system of transportation must be developed under which transportation lines of least natural resistance and cost of operation in relation to the service required will function without friction and without unnecessary restraint. Otherwise, railroad and terminal congestion, which has long been serious, will become more acute. The day of railroad monopoly of transportation is now forced to an end, just as the day of boat monopoly was forced to an end years ago.

The National Council of Defense has named a committee on inland waterways and has placed the Chief of the Army Engineers at its head. The committee is vigorously promoting the use of the waterways as a means of relieving the war strain on the railroads. On August 3 Congress finally adopted what is known as the river regulation amendment to the Rivers and Harbors Bill, providing for the creation of a cohesive, constructive and continuing national policy of developing and using the now wasted navigable waterways. Inaugurated by necessity, this development cannot fail to become a permanent factor in economic transportation in the United States.

Standardized Shipbuilding in Great Britain

GREAT BRITAIN'S first standard ship, a cargo steamer of 8,000 tons deadweight carrying capacity, was built in a little less than six months. Later vessels of the same type, it is predicted, will be built in from four to four and a half months. Two types of standard ships, both of the same size, are now being constructed, one a single deck ship and the other a two-deck ship. Smaller vessels of 5,000 and 3,000 tons deadweight carrying capacity, respectively, are also being standardized.

According to reports, the official trials of the first standard ship were successful in every respect. Although particulars regarding the vessel have not been disclosed, it is said that the design provides for a minimum amount of steel consistent with the requirements of Lloyd's, the British Corporation and the Bureau Veritas. The vessel is specially arranged to facilitate the rapid loading and discharge of cargoes, and the quarters for the crew represent a marked advance over the usual accommodations in ordinary tramp steamers.

With characteristic thoroughness, British shipbuilders are not limiting their efforts in standardization to an emergency design, but a committee has been formed, known as the British Marine Engineering Design and Construction Committee, which will frame rules acceptable to the Board of Trade and to the classification so-

cieties in connection with the design and construction of marine engines, boilers, condensers, auxiliary apparatus, propellers and shafting. On this committee are representatives of the principal marine engineering societies in Great Britain, as well as representatives from the Board of Trade and classification societies. It is believed that any standards developed by such a body, with proper provision for periodical revision, will not fail to bring the British marine engineering industry up to a high point of efficiency both as to quantity and quality of output.

Coastwise Shipping Bill

THE bill now before Congress giving the United States Shipping Board power to suspend the navigation laws relating to the coastwise shipping during the present war and for a period of 120 days thereafter, if enacted, will permit vessels of foreign registry to engage in coastwise trade of the United States under certain limitations and conditions. Such vessels can enter this trade only when granted permits by the Shipping Board limiting and defining the scope of the trade and the time of such employment. The Shipping Board is directed to give preference to vessels of foreign registry owned, leased or chartered by citizens or corporations of the United States.

This legislation is put forward purely as a war measure and is designed for the express purpose of securing the most efficient use of available tonnage. In the near future, practically one-third of our coastwise tonnage will be withdrawn for war purposes, and under present conditions this tonnage cannot be replaced, except by transfer from the Great Lakes, as practically all of the coast yards are engaged in the production of ships for foreign trade or for naval purposes.

Columbia University Offers Course on Ports and Terminal Facilities

COLUMBIA UNIVERSITY, New York, is probably the first higher educational institution to offer an entire course of lectures on the problem of the planning and equipment of the seaport as a vital factor in our national economy. Dr. R. S. MacElwee, of the Department of Economics, who gives the course, has had practical experience and an exceptional opportunity of studying European ports and their mechanical equipment, as he was connected for some time with the foreign business of a large American firm making elevators and conveyors. The lectures will be given at the downtown rooms of the School of Business, 203 Broadway, Mondays from 5.10 to 6.50 P. M. during the winter semester 1917, October to February.

The problem will be approached from the economic standpoint. The engineering features as such are only the important means to an end. It is estimated that the average cost to haul a ton of freight 240 miles is 74 cents (3/1). It costs 75 cents (3/1½) to handle it at the terminals. The increase in efficiency in both marine and railroad transportation has reached a point beyond which the further reduction of costs per ton mile must of necessity be small. The solution of further reductions in the cost of transportation must be found in the terminals. The link between ship and shore has been neglected and offers the greatest possibilities for scientific investigation and improvement. Port development has lagged in America and the congestion during the war has shown us all that we must mend our ways in order not to put undue burdens of cost on our foreign commerce in the sharp competition for the world's markets after the war. The merchants of the country begin to realize that the keenest engineers are needed to help them solve the problems of reduced costs to meet this competition.

Economic Importance of Seaports

As the ports of the country are of a vital national importance, transcending any local interests, it is necessary to make a careful analysis of what a seaport should be as a unit in the nation's economy. A port is a complicated affair and the tendency has been either to generalize without due regard for technical difficulties, or to become so completely engulfed in the fascinating engineering problems as to overlook some of the important economic features. Then there has been the tendency either to ignore the methods and experience of other peoples, or European methods have been held up as the only solution, to be Chinese-copied. Innovations have been attempted under conditions where they were sure to fail and then the failure used to discourage any attempt where the conditions were such as to make success more probable. We must work out our own salvation for ourselves in each case after exhaustive study of all available experience and peculiar local conditions.

Object of the Course

The object of the course is firmly to lay down the principles underlying the work which a port must perform as a co-ordinated and assembled piece of machinery. Then to take up in detail each of the various parts and its relation to the whole. In each case as many practical examples as can be collected for the purpose will be introduced to illustrate the point under discussion.

The readers of this paper can be of incalculable service by sending in to the lecturer any items, such as cost calculations of actual cases in operation and the saving over previous methods by improved installations. Also layout drawings and photographs are a great help, as the course will be illustrated as far as possible with lantern slides and exhibits. The variety of the material needed will become clear from the following outline of the subject matter of the course.

What the Course Covers

A general introduction will show the types of seaports, as to location and layout, with some historical reasons for the same and the dependence of a port upon its hinterland. The hinterland of a port extends to the point where the combined costs of moving freight through the port are equal to the costs of sending the same shipment through some competing port, or to the point where the traffic will not bear the costs. Thus a port is in a position to widen its hinterland by reducing costs of shipping through that port.

The study of the details will then begin at the point of contact between ship and land. Miscellaneous package freight only will be considered at first. How can a ship be unloaded, coaled, provisioned, loaded and dispatched in the most economical and expeditious manner? After the goods are on the wharf, how are they cared for? Where do they go and how are they to be moved there? If they are moved by rail into the interior, how is physical connection accomplished?

Freight Differentials

Here the interpellation of a considerable discussion of freight differentials in connection with port development becomes necessary. Also such details as marginal railroads, classification yards, handling c. l. and l. c. l. lots.

Packages may not move into the interior, but are destined for local consumption. This involves trucking. Then there is the warehouse for longer storage. How and where should they be constructed and how is freight moved to them?

Warehousing and Lighterage

In addition to the general merchandise warehouse there is the rising problem of cold storage and terminal markets for food products and perishable goods. This all involves inner harbor movement by lighter. The lighter is capable of infinite development in design and economy in connection with a better general layout of the port with all its parts.

Closely akin to warehouses are manufacturing plants which involve the entire question of the industrial harbor and the question of upland vs. waterfront property.

There is to be considered the movement into the interior by water. The Elbe has made Hamburg, the Rhine, Rotterdam, and originally the Erie Canal made New York. This involves barge terminals, mooring dolphins "in midstream" and various other accommodations.

River Port Industrial Harbors

The development of a water connection between port and hinterland involves the river port and also the river-port-industrial-harbor. The possibilities of this last development are so great as to stagger the imagination, especially as to what can be done to reduce manufacturing costs.

The river traffic brings into the port problem the handling of bulk freight from ocean to river vessels, in which Rotterdam has accomplished so much, as have also our own Great Lake ports. Even so, most of our bulk freight moves by rail. How is that managed? The ideal port must therefore have arrangements for handling and storing bulk and specialized freight, coal, ore, grain, coffee, cotton, bananas, oil, etc., and moving it by rail, barge, lighter or truck. This involves a correlation of special piers or basins to the whole and the need of a wealth of ingenious mechanical equipment which will continue to keep our engineers busy.

There is the important question of handling four classes of passengers with their luggage, and in addition express freight, such as gold shipments and United States mail.

A waterfront may also be a place of beauty as well as utility.

Administration and Jurisdiction

The nature of a port having thus been outlined and investigated in some of its details, there is the general question of administration and jurisdiction, with particular reference to the historical development of several successful port authorities. Then the fiscal aspects, including fees and dues, will be considered in relation to port administration, and the flow of traffic through the port in competition with other ports. The free port as an institution will require study in view of the present agitation concerning it, and in order to judge of its desirability or possibility on American soil.

Conclusion

A brief review of American and foreign ports will close the series. Each port will be criticised in the light of what has been discussed. This part of the lectures will have a direct commercial bearing on the routing of exports, necessary packing, etc.

The course is an ambitious one. The thirty periods of fifty minutes each will be none too long, but in that time much may be shown which will lead to a wider interest and understanding of the present and coming problem. The scientific improvement of our American ports concerns not only our engineers, economists and merchants, but also the entire American people.

LETTERS TO THE EDITOR

The Marine Oil Engine

An article in the July issue by Mr. John F. Wentworth on the marine oil engine interested me very much, as I fully agree with him about certain engines being pronounced a success while in reality they should be called absolute failures.

It seems strange that the entire engineering world has set their mind upon engines of the Diesel principle, with its numerous complications and disadvantages, while about the only thing that can be said in favor of the Diesel engine, as well as those of the surface ignition type (hot bulb engines), is the elimination of such a simple device as electric engine ignition. Electric ignition caused quite a good deal of trouble in internal combustion engines a few years ago, but since the perfection of the magneto, as well as the great improvements made in storage batteries, we find but few complaints from this source, and such troubles as we do hear about at the present day can all be traced back to gross negligence. Such people as cause these complaints can certainly not be entrusted with an engine of the Diesel, or so-called semi-Diesel, type.

I believe that the numerous automobile and marine gasoline (petrol) engines in use at the present time, and the majority of them in very unskilled hands, will bear me out with this statement.

The Diesel engine at its best is not a very flexible machine. If we compare it with a steam engine, the speed of which can be varied through such a wide range, we have, outside of its economy, absolutely nothing to say in its favor. The same is true with the surface ignition engine. There are several types of boats where flexibility of the engine speed is of prime importance. The most pronounced case of all is a tugboat, especially when wharfing a tow in a crowded harbor.

I have seen statements made by builders of Diesel engines to the effect that their engines can be started from stone cold to full speed in a few seconds. But how about from stone cold to slow speed? Will ignition take place? Any man who has had experience with Diesel engines knows the answer unless his idea of slow speed is that of a speed maniac.

In order to make an engine practical for direct connection to the propeller shaft of a vessel which is liable to operate in crowded waters, it should be capable of starting from a dead stop to no more than 15 percent of its rated speed, and kept running at such a speed for several hours. This may not be necessary very often, but when it is necessary it must be done or the engine is not suitable for the purpose. That such an engine is a possibility, I have sufficiently demonstrated with an engine perfected several years ago, which is the outcome of about twenty years of labor and experimenting. The pressure employed is no greater than in an ordinary gasoline (petrol) engine. It requires no special starting device, but is absolutely self-starting with the load on at a slow speed under all conditions even without the presence of an air storage tank. It uses the common heavy fuel oils at the same efficiency as any Diesel engine.

Jersey City, N. J. H. E. A. Raabe, M. E.

Co-Operative Management

Shipyard Strikes Point to Necessity for Better Understanding Between Employer and Employee

BY ARTHUR F. JOHNSON

THE chief obstacle to steady and efficient advance of manufacturing industry has been lack of understanding between employer and employee, and that this situation still exists may be testified to by the numerous outbreaks of recent occurrence, particularly in our shipyards.

Such friction at a time when every deterrent should be removed from the path leading to maximum output, speaks ill for our managerial systems as a whole and every effort should be directed toward alleviating conditions. Nor should such remedy be one arriving at temporary compromise through appeals to patriotic motives unless all grounds for certain reaction with return of peace are eliminated. It is manifestly unfair to require either participant in the controversy to abide inequitable circumstances while the other enjoys proportionate gain.

It is obvious that no permanent condition of harmony will be attained until the present method of adjusting differences has been considerably modified, the mutual distrust abolished and both the administrative official and the man in overalls have been educated to an appreciation of each other's viewpoints.

There can be no "scientific management" until it embraces all the factors introduced into production by the human element, and since all mechanical processes, however perfected, are dependent upon human control, an exhaustive study of the man is finally the criterion of successful achievement.

From the standpoint of the executive, more must be accomplished than the mere hire of minor heads who "know how to handle men," and the workmen must regard their firm through clearer vision than that limited to the pay envelope or the clock.

When each laborer in the plant becomes more important in the firm's estimation than the most modern and powerful machine in the works, and when the employee will stand by his firm regardless of strikes elsewhere, feeling that the firm has given him all that he can justly demand, labor disturbances will be fewer.

Cause of Labor Trouble

There are three general causes of labor trouble. First, dissatisfaction with working conditions on the part of employees; second, demand for increased compensation by them, and third, sympathetic protest against real or fancied wrongs borne by workers in other firms or in allied trades in the same establishment.

No firm ordinarily takes the initiative precipitating breach of relations for the good and sufficient reason that it has the prerogative of "hire and fire." The men, being organized and having no other weapon beside the strike or walkout, use their one defensive means as a constant implied threat to further their cause.

Analyzing the three causes of discord with a view to remedy, the ordinary working conditions leading to trouble are employment of non-organized labor, increase in or more usually desire for decrease in hours of labor, speeding up of production or attempt to institute standards for rates of doing work, unjust conduct of minor or major officials, attempted foisting of improperly skilled hands upon firms or protest against their discharge, and most frequently a misunderstanding of institution or abolition of customs.

That the men are justified in organizing is acknowledged by all fair-minded employers, but that they have the power of dictation as to personnel employed is questionable. The fact that a worker satisfactorily performs his allotted task is all demanded of him on hire, the question of union being a personal matter between the worker and his associates, who should be sufficiently fair not to foist distastes upon an irresponsible third party. An employer can constitutionally no more demand that a skilled workman join a union than that he be of a given political belief, such conduct inevitably resulting in loss of prestige. It may be and is implied that firms are "strictly union" or "open shop," but should circumstances arise demanding choice between modified aspect toward labor organization and failure, the policy would most assuredly undergo change and that without serious detriment to output if properly administered.

Protracted consideration of this question is uncalled for, there having been frequent and exhaustive discussions thereon, to no evident purpose. Suffice it to state that in a plant brooking no outside interference and treating its men with fairness and firmness of policy, success can and has been attained in the treatment of this subject.

Eight-Hour Working Day

The question of appropriate length of working day has very probably been decided by the lead of requirements imposed in case of Government contracts, where the eight-hour day was stipulated. This resulted in almost universal adoption of eight hours as the period beyond which labor would prove inefficient, due to loss of energy on the workers' part and longer than which it was inadvisable to permit labor except in emergency. It is possible that the workmen may desire shorter days, but with scant hope of attaining the desired result. Such further reduction would be unjust to the work and entirely uncalled for unless in extremely arduous vocations where the matter has adjusted itself through special skill requisite, consequent scarcity of qualified men and desire to retain those of proper caliber.

A revision of the time per day upward is very improbable, but that all firms should adhere to eight hours is fair and a matter of economy. Any firm principled to the contrary will have difficulty in the future and is, without doubt, now having it. Though there may be endless applicants to replace the wornout personal material in an overworked shop, it is a matter of national expediency that the stamina of the working classes be maintained.

Speeding up of production is the proper desire of well-organized industry and protest against its wrongs is to a great extent without just cause, even though the introduction of many really fair and economical systems has been balked. It is on this topic that the greatest amount of missionary work is capable of accomplishment with the possible exception of the curious misunderstandings constantly cropping up between the two factions.

Each industrial establishment has multitudinous small

leaks which are constantly being studied with a view to their elimination and of which new ones spring up with each innovation in procedure or complication as result of normal progress. The persistent limitation to advance in shop practice is the worker or his organization. Absolutely mechanical phases of the processes are ordinarily perfected to maximum degree, it being the co-ordination of man and machine in which the carefully planned system proves practicable.

Tradesman's Point of View

The average tradesman views with suspicion anything tending to alter his "tricks" and is also very jealous of the skill which placed them among his invaluable accomplishments. Occasionally there is reason for his pride, but more often a thorough familiarity with good manufacturing practice and innovations would point out the impropriety of or at least opportunity for improvement in most of them.

Until these prejudices and attitudes of self-sufficiency are corrected, little hope may be entertained of marked advances in efficiency. Once the evil has been erased the notable gain will elicit wonder as to the delay in instituting corrective measures, particularly in view of their simplicity.

The normal executive or technical member of a firm's personnel acquaints himself with improvements in the industry through literature, membership in organizations of specialists in his line, etc., applying the information so gained to the peculiarities of his establishment. The ability to bring this about is facilitated by his fundamental education.

The tradesman, on the other hand, is not so advantageously situated with respect either to information bearing printed matter, specialistic affiliation or degree of schooling. Trade journals exist, it is true, but whether of proper attitude and edition suitably to set forth the really important matters of the particular calling is doubtful. Granting that these improbabilities are so, their intimacy with the particular firm and its institutions are not in keeping with the personal tone requisite to insure careful perusal after a day's manual labor. Several firms have established their own editorial staffs and thus gone a step in the right direction.

A plant in which each workman understands the details of his duties has been taught to seek improvements, no matter how trivial, and appreciates the relation of his step in the process to those preceding and supplementing his, need anticipate no opposition to efficient and just innovations.

Personal Interest Essential

The innoculation of each employee with the "personal interest serum" would entail little cost other than the efforts and application of spare time by executives who at present waste many hours in worry over this very problem.

Primarily the interdependence of master and man must be realized and full advantage taken of good to be attained through conferences. With personal acquaintance, not impliedly demeaning, distrust will be minimized and confusion due to misunderstanding obviated. In many plants the department heads meet regularly to formulate programmes and then meet with the various shop foremen to perfect the details. This plan should be further elaborated by "shop conferences" between workmen and foremen, supplemented by regular meetings of entire departments, at which lectures could be given and open discussion indulged in.

It is to a firm's advantage to take active interest in the men's spare time and to assist them in spending it profitably. This can be brought about in one of two ways. The present labor organizations may be rendered more clublike, educational features and social events being fostered by the company, who might even assist in providing proper club and reading quarters. This feature would be on the nature of railroad Y. M. C. A. work, with the added essential of including the men's families wherever possible.

Regular classes could be established, affording study of the firm's methods and details of each operation in the process. Attending such classes would be compulsory for all apprentices, and even for newly employed mechanics, as well as office and technical men. Regular and seasoned workers would be given periodical instruction in improvements and contemplated innovations, while the suggestion box would be open to contribution by all concerned.

With regard to the heightened personal interest it would be to the firm's interest to afford opportunity for purchase of preferred stock or "baby bonds" by every employee, the payments being made on the installment savings plan.

Co-Operative Manager

The entire foregoing field should be under direction of a "co-operative" manager, affiliated with the staff of the industrial manager and responsible for all matters of personnel. Through him the foremen would hire their workmen and they would consult him frequently. The men should feel that they were encouraged to air their grievances with him and that all matters would be treated in confidence. This office would edit the yard paper, which would contain personal and lighter matter in addition to instructive articles of direct bearing on the work. Exchange items would keep the men informed as to matters in other firms of similar character, and there might even be an exchange employment bureau.

There have been instances in which incapable mechanics became attached to the rolls and possessed influence enough with their associates to draw forth protest against their discharge. This has at times resulted in local disturbances annoying and of a nature to render the labor organizations less favorably regarded by the executives than had they suppressed such unfair tactics.

To a great extent this has been eliminated, the men indexing or recording experience among themselves that a usurper might not aspire to employment justly due one of their number better fitted to perform the work.

The unjust conduct of minor officials has also been reduced to a minimum by the issuing of prescribed rules on the firm's part.

The frequent squibbles are, as previously stated, brought about by lack of understanding and can be reduced in ratio to the effort applied toward mutual study of the situations.

"Arbitration" is inevitable in settling labor disputes. Why not get together before the minor sources of dissatisfaction accrue to the point of forcing actual break? Why not look into the actual living expenses of an average family and equitably adjust wage rates to provide a slight margin for savings? Why not divert a small percentage of dividends to those who have wrought the producing medium, whether it be in stock manufacture or contract work? Why not teach the human members of the mechanism their true relation to the whole, capitalizing in this way the wonderful possibilities dormant in a mind forced into routine conception of its task?

The question has been and will continue to be an issue,

more and more prominent as the standards of living advance and the prices extorted make it difficult to keep abreast of them.

Why cannot the promoters of industry co-operate to study the vital problem of keeping the value of our specie at a standard instead of permitting it to constantly decrease in purchasing power?

The constant advance in prices in previous years must be checked and the appropriated champions of this effort should be those producing essentials of life and progress. Theirs is the knowledge that, regardless of price, a given concrete value attaches to their product and that it is not for manipulators to set the standard of worth, but the actual cost in drain on the supply of raw material and energy entering into the manufacture.

When the producers have realized this truth and acted to return our national to its approximate specie value, the question of compensation will have solved itself.

The entire discussion summarizes itself in the statement that "scientific management" as heretofore developed must be broadened to include precise study of the individual. That this research must result in a thoroughly American solution, subordinating any tendency toward the philanthropic and merely putting it before the man as a good, sound business proposition, making him realize that in working for a company he is working for his ultimate gain, the firm tiding him over the thin ice in his embryonic period of employment and encouraging him to put forth his best efforts with assurance of appreciation thereof.

Manning of Our Future Merchant Fleets*

American Ships Must Be Sailed by American Officers and American Crews to Make Our Merchant Marine Permanent

WITHIN a year, in all probability, the United States will possess a mercantile shipping tonnage more than double what we had at the outbreak of the war in Europe. We will have, more than that, a greatly increased capacity for building ships and an impetus in building them that will have got American capital and organization actively interested in planning a future expansion of the most efficient use of ships under our flag in the world-wide transportation of American commerce. The U-boat necessities, that have stimulated us to such instantaneous doing of what the necessities of our expansion and intensification of commercial effort called for before as a constructive national development, will probably have been met. There will then be more discussion of the things we must do to make a further, permanent development of our merchant marine. And one of the things to do will be to make the business of sailing American ships one that will attract and hold American officers and crews for the ships to come. For in American sailormen on American ships rests the American opportunity for doing in ocean navigation what we have done with our railroads.

The problem of manning the ships that will carry our troops and our supplies to France and our munitions and food to our Allies is already pretty well solved. There may be certain complications, but there exist the ready means for raising men for this phase of warfare. The real problem, as men who are in touch with what is being done with building the new mercantile navy now see it, is to provide for the time of peace after the war, when a very important element in the international contest for commerce is going to be the organization of systems of navigation along national lines. England and Germany are both preparing for this. Germany has recently announced a policy of subsidy to encourage rebuilding of merchant ships: owners who replace seized or sunken ships within three years may receive 60 to 80 percent of the then market cost of construction; the ships replaced between four and six years will receive a subsidy of 40 to 60 percent of the cost then; and reconstruction delayed till the seventh, eighth and ninth years will receive from 20 to 40 percent. The subsidy stimulates rapidity of shipbuilding, diminishing as it does in two ways, that is, in the percentage of total cost of a ship and in the presumed reduction in the general cost of construction, the subsidy being based upon the market value of the ships at the time of their completion.

Right at the moment, England is bending all the energies of her steel and shipbuilding capacity to the construction of the small, fast vessels designed to meet the U-boat campaign most effectively. But there is reason for believing that the British shipping interests hope for Government coöperation in a programme of large dimensions in which the cargo-seeking "tramps" of 10,000 tons deadweight capacity which shipping experience calls most economical for peace-time trade, and giant steamships (or motorships) running on regular lines and advantaged by having preference and privilege in a system of harbors strategically placed in all parts of the Empire, will serve the behests of British commerce.

In England it is predicted that our development of future shipping is to take the form of regular lines of great, fast steamers and of special fleets owned by single corporations and combinations of them which will be used as delivery systems, perhaps offering some public service also. We will not do much with the "tramp," in English opinion.

Form of American Shipping Development

The form our development of shipping takes will have an important bearing upon the problem connected with the manning of our ships. If the English who make the above predictions are right, and their prediction is based upon a shrewd and experienced judgment of the nature of ocean navigation, the American policy as to ships will fit exactly the American policy as to the merchandising of manufactured exports in foreign trade—we will not attempt the competitive sale of cheap goods, but will make

* From *The Americas.*

our campaign upon the economies of quality, both in articles and in transportation. For ten years before the war we had been increasing our sales of manufactures in many far-away countries because our business interests were going after the markets in earnest, using our best salesmen, our best sales methods, and goods the manufacture of which had been so organized as to obtain quality of one kind or another through economies of efficient, highly paid labor and well-designed machinery as against mere cheapness of product. Analogously, we shall probably do very little with "tramp" cargo-seekers that roam the seas and pick up their crews wherever men can be found cheap. We should develop the economies of thoroughly organized "big" shipping, in which we can best use the best type of self-respecting American labor, making the conditions such as to attract this class of steady, sober men.

Training American Boys for the Sea

Will it pay to take American boys and give them training by thousands for the merchant marine as boys are trained for the navy? That may be a question for the practical economies of America's coming development of merchant shipping in big units to solve, or it may be taken up as a fact and organized in the national interest.

Twenty-five years ago only 40 percent of the crews of the United States Navy were Americans. We now have practically a 100 percent American navy. To-day, according to Andrew Furuseth, head of the International Seamen's Union of America, only 28 percent of sailors on American merchant ships are Americans. Anybody who has pictured what "American merchant marine" we had as American ships manned by American sailors, was mistaken. Our ships are overwhelmingly manned by floating foreign labor. On August first there were 5,000 enemy aliens employed on American ships, for the most part in the engine rooms.

The labor on most American seagoing ships is floating labor in the sense that it does not stay on any one ship. The majority of the sailors on American merchant ships sign only for the one voyage and are on a different ship a few days after returning to port. Thus we have a merchant marine manned by crews the majority of which have no particular fealty either to country or ship. They can hardly know their ship or their officers.

National Policy

There appear to be two policies that may be adopted by us, nationally, for the future manning of our merchant marine. One contemplates a continuation and extension of the present system of having crews of indiscriminate nationality on our growing merchant marine. This policy is now embodied in the present Seamen's Act. That act was written by the supposedly American sailors' unions and Mr. Furuseth in a recently published pamphlet speaks with great pride of the national policy created in it. The Seamen's Act gives an American sailor the right to quit his ship and compels the ship officers to pay him half the wages due him in any port, making illegal any contract he may sign before shipping that would otherwise hold him. It gives sailors on foreign ships the right to quit in any American port and demand half pay also (collecting the rest later), nullifying all treaties by which we and other nations heretofore prevented the desertion of sailors.

Mr. Furuseth claims this as a constructive American policy not merely to give "sailors rights," but to obtain foreign sailors for American ships and raise the standards of pay on foreign ships also. By deserting in an American port to get American wages, he says, the foreign sailors force foreign ships to pay higher wages. As far as the mere rate of wages goes, this has been the result, during the exceptional times since the Seamen's Act came into existence. Some American shipowners do not hesitate to agree with Mr. Furuseth so far. But they do not agree with him in regarding the thing as a wholesome American policy, either as a way of obtaining a supply of sailors or as a way of increasing the operating costs of the merchant navies of other countries to the level where we may evenly compete with them.

It would fasten upon the American merchant marine the mongrel crew and make more difficult the Americanization of American shipping. It is no great help to American shipping to have the individual wages of foreign sailors put up as high as the wages we pay, if fantastic requirements remain in the law by which an American ship must carry a lot of useless men while the foreign ships sail with smaller crews, and if the number of American boys permitted to sail on our ships is limited by having the relative proportions of "able seamen" and of apprentices and ordinary seamen fixed in the law to suit the unions. It is understood that the seamen's unions have consented to a tacit suspension during the war of some of these limitations, having threatened a virtual boycott of American shipping at this critical time if the Seamen's Act were modified in any way.

Americanize the Crews

However, there is much opinion among American shipping men in favor of something that will Americanize the crews as well as the hulls of our coming merchant fleet. A veteran officer of the navy, who is much interested now in the merchant marine, sees the development of American marine transportation efficiency coming which will require a better standard of personnel in the crews and be able to pay wages and make the career attractive. He calls attention to the great and growing fleet of one of America's greatest corporations, that has found having its own fleet is economical because it is more effective in its world-wide merchandising. The sailors on this fleet have a high proportion of Americans, the wages are above the standard, the accommodations for the crews are better than any law requires. It all pays. Presumably this corporation finds in more careful, efficient handling of its ships and its cargoes, and in having control of its own service, the economies that make it pay.

Subsidizing Man-Power of the Merchant Marine

The head of an important shipping consolidation in South America recently proposed to the Argentine Congress that the nation subsidize the man-power of its mercantile marine so as to encourage shipping and at the same time train men to operate its future war vessels. His plan was to create a large naval reserve of officers and men, the nation recruiting, training and paying them, and hiring them to shipping concerns on such terms as would make Argentine shipping pay. There is some such project advocated in this country, but the propaganda has not got much of a start yet. If the nation sees its advantages in having an American merchant navy, with self-respecting American boys taking to the ships as they do to railroad work or to mechanical pursuits, we might easily establish permanent training stations like Newport for young sailors, give them a "setting up" drill and all-round education in seamanship together, making the course such as to open to ambitious boys the opportunity to become officers. And we might go further with some national stipend which would be the equivalent of a bounty on seamanship. We could then have any standards of nautical service we might desire, taking the economic burden off the competitive operation of American ships.

Apparatus for Interpreting Stability for the Use of Shipmasters*

Stability of Vessels Under Ordinary Conditions of Loading Shown Graphically—Assumptions Made—Accuracy of Results

BY THOMAS GRAHAM, B. SC., R. C. N. C.

The object of this paper is to describe a simple apparatus whereby the stability of vessels under any ordinary conditions of loading can be shown graphically, and easily interpreted by shipmasters and others to whom the subject is of practical importance. The apparatus to be described has been designed to co-ordinate and employ fully the existing information supplied to vessels, namely, draft, deadweight, and displacement scales, metacentric diagram, and stability results.

To recapitulate procedure and to provide a working example, the calculation for the metacentric height of a vessel in the load condition is as follows:

Item	Weight in Tons	V.C.G. Above Keel in Feet	Moments in Foot-Tons
Ship in light condition.....	3,900	21.3	83,000
Coal	1,000	17.0	17,000
Cargo	3,500	20.8	73,000
Crew, stores, fresh water, etc..	50	25.0	1,250
Reserve feed water.....	100	2.0	200
Load condition of ship....	8,550	20.5	174,450

Height of transverse metacentre above keel = 22.3 feet
Height of C.G. above keel = 20.5 feet
"G.M." = 1.8 feet

In the above summary the cargo forms the heaviest item of the deadweight, and, as usual, is assumed to be homogeneous, the centers of gravity being reckoned coincident with the centers of volume of the spaces containing it. The result admittedly applies to only one type of cargo and stowage, and in the majority of cases this varies from voyage to voyage. The object, therefore, is to devise a system which shall so co-ordinate and adapt the information available to shipmasters as to render it applicable not only to one particular form of the above table, but to an infinite number of variations of it representing the conditions for all cargoes, homogeneous or otherwise.

To effect this by the method proposed, two assumptions are made:

(1) That each compartment into which cargo is placed is filled by that cargo to the underside of beams, in order that the center of volume of the hold or 'tween deck may always represent the center of gravity of the cargo.

(2) That the cargo placed in each space is homogeneous, though not necessarily homogeneous throughout the ship.

In the majority of vessels another approximation is justifiable. The heights of the centers of volume of the holds throughout the ship vary so little, that an average height may be assumed for them all.

In three typical cases the heights above keel of centers of volume of holds are as follows:

* Read at the Spring Meetings of the Fifty-eighth Session of the Institution of Naval Architects, London, March 28, 1917.

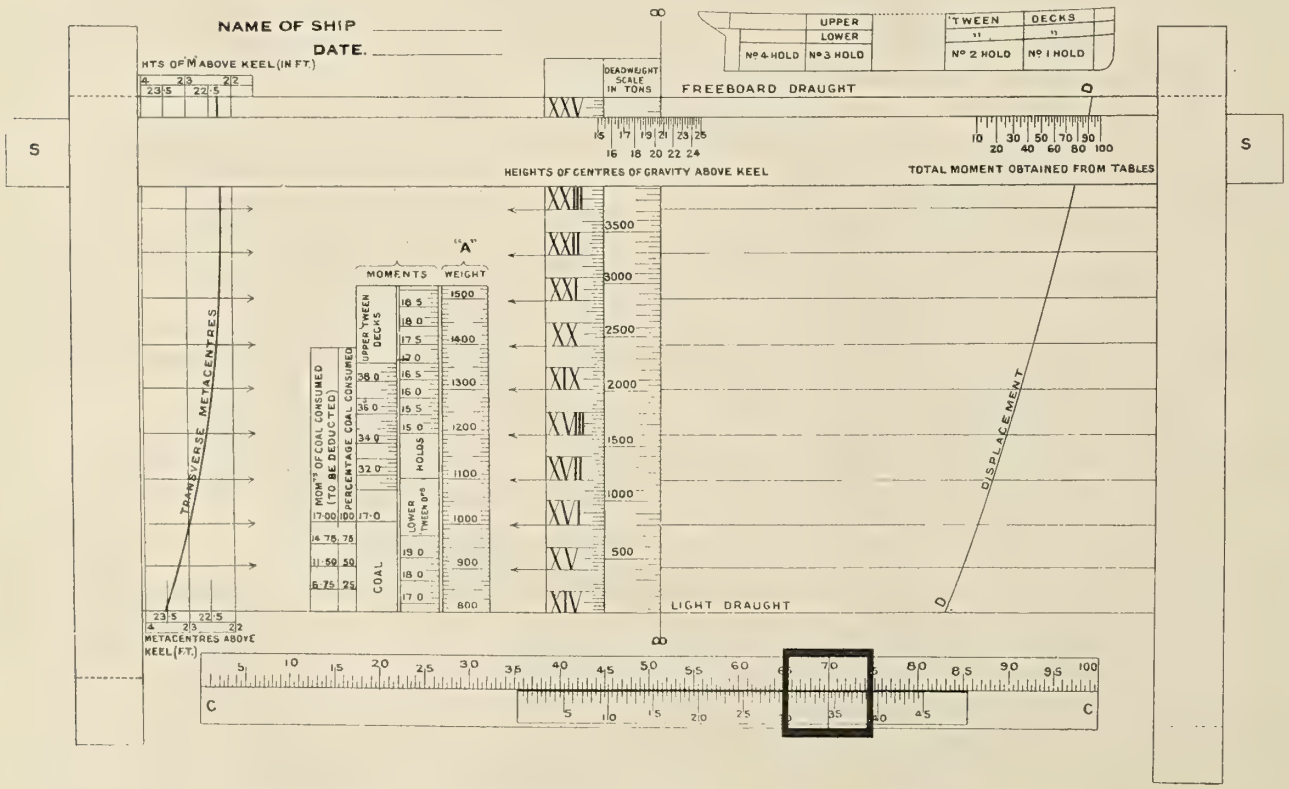


Fig. 1.—Chart Embodying Draft and Deadweight Scale and Curve of Transverse Metacenters

	1 Passenger and Cargo Vessel. Length 400 Feet	2 Cargo Vessel. Length 370 Feet	3 Cargo Vessel. Length 320 Feet
	Feet	Feet	Feet
No. 1 hold (for.)	14.1	17.5	17.4
No. 2 hold (for.)	13.4	15.8	16.0
No. 3 hold (aft)	13.2	15.5	15.6
No. 4 hold (aft)	13.7	16.7	16.5

No serious error, therefore, is involved in these and similar cases by taking an average height for all the holds. The 'tween decks can be similarly dealt with.

By doing this, work is greatly reduced, as with the conditions laid down in the second assumption, the total moment of cargo about the keel is directly proportional to the total weight of cargo, irrespective of the density of the cargo in separate holds or 'tween decks.

The chart shown on Fig. 1 embodies a draft and deadweight scale and a curve of transverse metacentres—information which is supplied for practically every vessel.

A is a scale of weights set up in any convenient units of length, ranging from the lowest to the highest probable amount of cargo which any compartment, or group of compartments similarly situated with respect to height, is likely to accommodate when full. In this case the lower limit is 800 tons and the higher 1,530 tons, the former figure being reckoned to underestimate the lowest weight of cargo which the smallest group of compartments (lower 'tween decks) will ever carry, and the latter figure exceeding what can reasonably be supposed to be the maximum contents of all the holds. Adjacent to Table *A* is a series of other columns designated "holds," "lower 'tween decks," "upper 'tween decks," and "coal." These contain scales of moments about the keel, of the cargo in the respective compartments corresponding to the concomitant weight values in Table *A*. Thus, if 1,450 tons were placed in the holds, the moment of that weight, namely, 18,200 foot-tons, is obtained in the corresponding "holds" column. Similarly, if 900 tons and 1,200 tons were put into the lower and upper 'tween decks respectively, the corresponding moments are 18,650 and 34,600 foot-tons. And so if all the items of deadweight be observed and summed in this way, the total moment of the deadweight about the keel for any distribution of cargo is known.

For work of this kind the values of the moments are represented with a reasonable degree of accuracy by the first three significant figures, and in consequence the values in the columns of moments have been expressed in thousands of foot-tons. This, too, eliminates figures of high magnitude from the chart, which is desirable.

C C, Fig. 1, consists of two similar scales, one of which is fixed and the other adjustable. A cursor is supplied for use in conjunction with these scales, in construction similar to that used on the ordinary slide-rule. The order of magnitude of the graduations on the scales being the same as that representing the moments in the columns (i. e., moments multiplied by 10^{-3}), the summation of the moments is rendered automatic. Thus, if as before 1,450 tons be placed in the holds, the moment is 18.2. Place the origin of the sliding scale at 18.2. Next 900 tons are put into lower 'tween decks, giving a moment of 18.65. Move the cursor to 18.65 in the sliding scale and read off 36.85 on the fixed one and so on, the process of summation being continued until the full load is on board, which, to pursue the example taken, might be 4,500 tons with a moment of 90.0. Stores, fresh water, and reserve feed water having a small moment in the case cited, have been included in the light weight of the ship.

It may be noticed that the inclusion of water ballast, if carried in the double bottom, may be treated solely as an increase in deadweight.

The curve *D D* is displacement curve plotted logarithmically about the datum line *x x*, and *S S* is a scale graduated logarithmically to the same unit as the curve. This scale can be adjusted so as to facilitate the reading off of deadweight and moments at any draft, and also can slide in the direction of the ordinate of the displacement curve, so that the operation of division can be performed logarithmically.

Up to this point nothing has been said of the light ship and its moment about keel. The latter is allowed for in the scale *S S*. Thus, in the example taken, it was found that the total moment of the 4,500 tons of deadweight was 90.0, but the corresponding 90.0 on *S S* is arranged to represent 90.0 + 84.45. the total moment for the light condition. Hence, if this 90.0 on *S S* be placed coincident

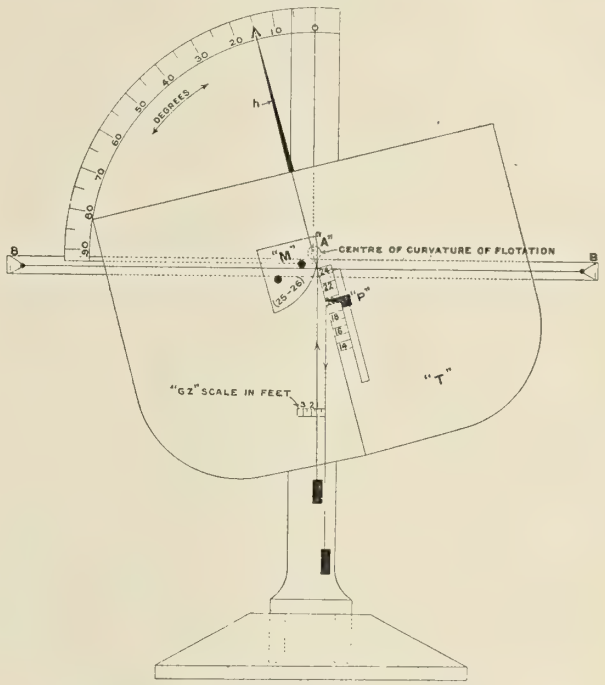


Fig. 2.—Diagrammatic Sketch of Indicator

with the displacement curve at the draft for 4,500 tons of deadweight—namely, 25 feet—the height of *G* above keel will be indicated on *S S* at the datum line *x x*, since log. moment—log. displacement gives the quotient in feet on a log. scale. Then from the adjacent locus of metacentres the *G M* can be obtained.

For the convenience of deducing the results at intermediate conditions such as those in which the coal is 25 percent, 50 percent, or 75 percent consumed, the "coals" table provides the weights and corresponding moments at these percentages, which will be deductions from the total weight and moment.

The whole operation is simple and accompanied by a degree of accuracy not much inferior to that which would be obtained by working out the results in the ordinary manner in a designing office. As a rule vessels are chartered for definite shipments, so a chart of this kind would be employed in the harbor of loading and the operator would have to concern himself only with observations of the draft and consultation of the deadweight scale.

For the purpose of interpreting the stability of ships at various angles of heel the indicator shown diagrammatically on Fig. 2 has been devised.

This instrument illustrates three features of stability which are of most practical importance, viz.:

(1) An automatic record of the variation of the right-

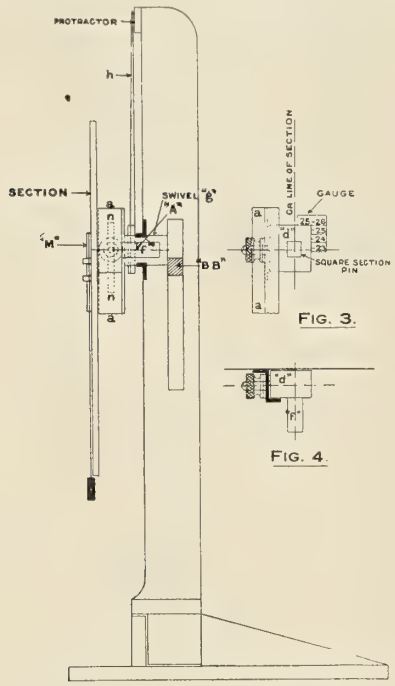
ing arm as the ship heels over from the upright to the vanishing angle.

(2) The approximate angle of heel at which the freeboard deck edge becomes awash.

(3) The position of the waterline throughout the range of moderate angles met with in practice.

T is a plane wood lamina representing the 'midship section of the vessel to any convenient scale, say ¼ inch to the foot, which can pivot about the point *A* in a vertical plane. On a protractor surmounting the section, degrees are marked off with respect to *A* as origin, so that as the section is displaced from the upright the angle of heel is indicated by the pointer *h*.

On the center line is a scale of feet graduated from the keel upwards, and a brass pointer *P* moving in a slot can be adjusted to any particular height on the scale. A plumb-line, consisting of a silk thread with small brass



Figs. 3-5.—Adjusting Device

weight attached, indicates the line of action of gravity of the ship at all angles of heel when hung over the pointer, the latter having been adjusted to the height of center of gravity above keel as determined by the use of the chart. *M* is a brass plate whose curved edge represents the metacentric evolute for the given draft and displacement.

On the section two screw spigots are fitted which pass through *H H*, holes drilled in the plate, and receive small nuts which fix the evolute rigidly to the section. Arranged to pass over the edge of this evolute is another plumb-line similar to the one described, and as it must always hang tangentially, the thread will be coincident with the vertical through the corresponding center of buoyancy for any angle of heel and will consequently represent the line of action of the buoyancy.

The distance between the two threads thus shows to scale the magnitude of the actual righting lever at all angles of heel, and for the purpose of observing this dimension a small scale of feet is attached to the gravity thread.

With regard to the plate *M*; as the metacentric evolute changes with change of draft, a series of these plates is supplied for any particular vessel, each plate representing a mean evolute over a relatively small interval of draft. It is found in normal forms of ships that 12 inches is a suitable interval, and the total range of draft which the supply covers extends from the lightest "arrival" condition (i. e., with all coal consumed and a cargo load in accordance with the lowest scale laid down in the deadweight columns on the chart) to the freeboard condition. To facilitate ready adjustment each plate has the interval of draft to which it corresponds engraved on it, thus (23—24), (24—25), or (25—26), as the case may be.

The feature of the apparatus remaining to be described is the arrangement for indicating the position of the waterline at moderate angles of heel. The point *A*, Fig. 2, about which the section pivots is a mean position of the center of curvature of flotation, the question of the fluctuation or assumed permanency of which is discussed in a subsequent paragraph. *B B* is a horizontal beam passing through a slot in the standard supporting the section, and capable of vertical adjustment to any required draft when

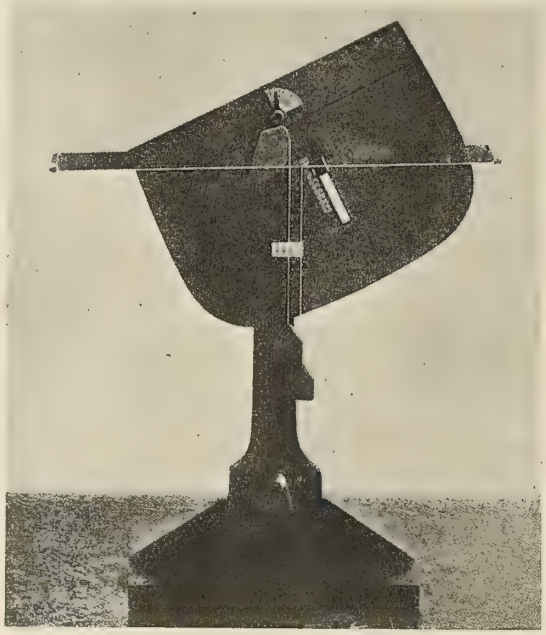


Fig. 6.—Photograph of Indicator

the section is in the upright position. A thread connecting the extremities of *B B* stretches across the face of the section so as to represent a waterline. Then, having adjusted *B B* so that the thread coincides with the particular draft before inclination, and assuming that the curvature of flotation is an arc of a circle up to angles of 30 degrees, the thread will indicate the position of the waterline as the ship is displaced through this range of angles.

Reverting to the point *A*; in many forms of vessels the C. C. F. (center of curvature of flotation) of successive drafts between the "arrival" and deep load conditions varies so little in absolute height that a mean fixed position can be allocated to it. This greatly facilitates construction and working of the apparatus, as will be inferred from the reproduction of photograph shown in Fig. 6.

In many other forms of vessels, however, especially in cargo ships, the absolute height of C. C. F. varies considerably, and therefore an adjustment of the point *A* becomes necessary to secure greater accuracy of result. Figs. 3—5 illustrate the adjusting device. A guide *a a* fixed to the back of the section accommodates a sliding piece *d* which can be adjusted to any required height by a screw and nut arrangement working in a slot *n n* in the guide. A pin *f* of square section fits into a swivel piece *g*

attached to but free to rotate in the vertical post of support, and the pointer h keyed to g indicates degrees of heel on the protractor already referred to.

The actual adjustment of A is controlled by a gage as shown in Fig. 3, which indicates the mean position of the C. C. F. over each of the 12-inch intervals of draft, for which the M plates are provided. Thus, if a vessel were floating at a draft of 24 feet 6 inches the M plate marked (24-25) would be placed in position and the slide d adjusted until its top edge were coincident with the mark (24-25) on the gage.

The value of this indication of the waterline at moderate angles of heel is apparent, as simultaneously with an observation of the righting arms, there is provided a visual representation of the position of the deck edge relative to the waterline.

To illustrate this, the case of a shade deck vessel with openings between the upper and shade decks might be given. The vessel has a beam of 53 feet and a freeboard of 5 feet 9 inches. The range of stability is 84 degrees and the maximum righting moment occurs at 45 degrees. At 13 degrees the upper deck edge would be awash, and at 20 degrees the water would pass through the after openings in the side. This aspect of the condition of the ship is not observed in the ordinary curves of stability, but is readily suggested by the apparatus described.

Of the limitations of the apparatus the author is fully aware, but where otherwise complete absence of knowledge might exist, it provides a means of obtaining accurate results appropriate to most of the great variety of conditions in which ships are liable to be found. An endeavor has been made, too, to make the apparatus and its operation as descriptive as possible, so that masters with "extra" certificates and other officers possessing an elementary knowledge of naval architecture may have a clearer comprehension of the part of the problem of stability concerned.

Cast Steel Ships

BY MYRON F. HILL

ACCORDING to latest accounts from England, ship losses of the Allies approximate 3,600,000 tons in six months, not including damaged ships laid up for repairs. Construction has amounted to 200,000 tons per month, leaving a net loss of 2,400,000 tons in six months, or 4,800,000 per year. The German admiral declares this will win the war for Germany.

Granted that the United States is reducing the net loss by increased construction, it nevertheless appears to be true that the increasing transportation requirements for throwing our strength into the war are not yet yet forthcoming. When America is faced with a problem and realizes its gravity, however, it is half solved.

There are many limitations to shipbuilding, and chief among them are the lack of skilled labor. Shipbuilding as now carried on requires expert knowledge of joints and laps, rivets and bending of plates, assembling of the right plates and of the right dimensions in the right places, and countless other factors requiring long training and experience. Other limitations, such as materials and facilities, are more quickly available—if necessary.

In an effort to brush aside the skilled labor difficulty the cast steel ship has been designed. It is formed in sections for casting, and the sections are welded together. No skilled labor is required because the brains are in the molds.

Cast steel has the same tensile strength and elastic limit as rolled steel, and a trifle more. Elongation is the same, but as the steel requires no bending this is of minor importance. Cast steel ships weigh less than riveted ships. All rivets, brackets, angles, straps and other connection metal is saved. This adds 10 to 15 percent to the tonnage that can be built from available steel—and steel is precious.

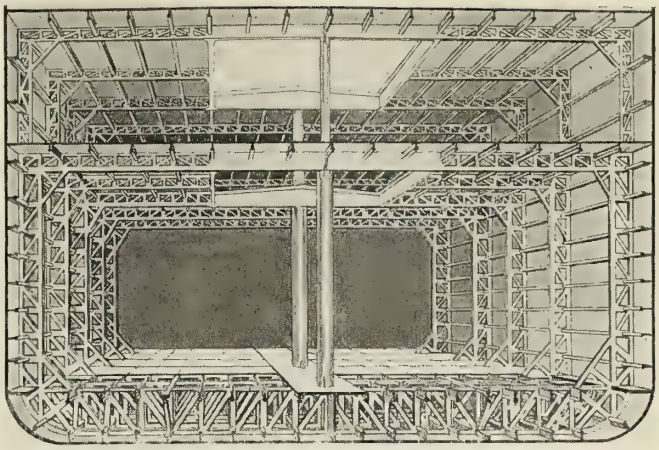


Fig. 1.—Section Through Cast Steel Ship

Welded joints are as strong as the steel itself. The most carefully made five-row riveted joint is only 95 percent strong. The welded ship is therefore 5 percent stronger for this reason, and stronger also because lighter. Further saving of metal is therefore possible when Lloyd's rules are modified to fit the proved factors.

Ship girders when cast in the form of trusses establish the form of the ship, and the plating, decks and tank top may be cast with the trusses as indicated in the figures or may consist of plates welded to the trusses. If cast with the trusses the latter may be located at the edge of the plating or in the middle.

The intermediate longitudinals may be cast with the plating in very heavy ships, or rolled as usual, cut off to space the trusses apart and welded to them and to the plating in spots. In this case the trusses are cast separately in sections and welded together. They are labeled in the molds, designating their location in the ship. A schoolboy accustomed to engineering toys could supervise their assembly.

Castings vary slightly in contraction. Large numbers of them are duplicates and are sorted according to size to fit closely. When building a number of ships at the same time this assorting process provides castings that fit each other sufficient for welding.

By casting the trusses alone, casting is reduced to the

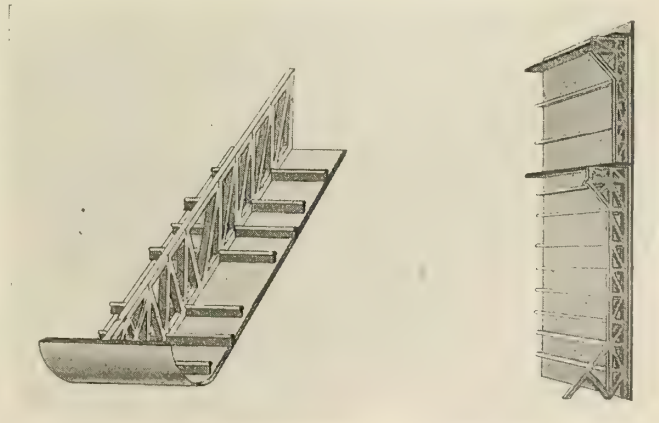


Fig. 2.—Typical Cast Sections to be Welded into the Ship

simplest foundry engineering. The transverse trusses may be cast in four sections—two bottom sections meeting at the center girder formed of plates, and two side sections. Deck beams may be cast separately and unite the side sections as the latter are faired up. The longitudinal truss sections may be welded to the transverse girders and the bottom girders held square by welding on the keel plates. The intermediates of rolled bulb angles (omitting connecting flanges) to length are dropped into place on lugs and welded to the girders.

The frame is then ready for laying on the skin, tank top and deck plating. The tank top and deck plates are welded at their edges to the main girders, and by means of punched holes are welded to the longitudinals. For ships of 9,000 or 10,000 tons the skin plating is heavy enough to cast with the trusses, as shown, or with the intermediate longitudinals and then welded to the frames.

The casting of large numbers of duplicate parts facilitates machine molding. Patterns for trusses, or the core or block system for more complex castings may be used, and each man trained in a few months to his particular job. Feminine labor for finishing the simple molds for trusses might be considered.

The cost of casting sections, if the foundry is a big one casting hundreds of ships, is reduced to a figure considerably less than that paid for riveted ships to-day.

Welding may be done by labor that has three weeks' training. The Wilson arc system is efficient, as proved by the experience of the Navy Department in welding the German interned ships. The weld is stronger than the metal that is welded. The cost of welding is insignificant—a few dollars per ton.

Ships can be turned out by this method in a small proportion of the time required by present methods. The ease and rapidity of assembling the frame makes it possible to put a large number of welders at work soon after assembly begins and a ship can be finished in short order. This economizes on ways.

By testing castings with the magnetic system results are certain. Flaws are healed by welding.

There can be no question that Germany knows our limitations in shipbuilding as well as we do, and is banking on them. It is stated that we can now roll 2,000,000 tons of ship plates a year—3,000,000 tons more are vitally necessary.

This is the situation that demands casting plates. Plates, with or without intermediate longitudinals, for ships of 9,000 tons up can be cast, and some of the plates for smaller ships. Furnaces and molds are required. It takes six weeks to build an open hearth furnace. Even blast furnaces may be added to the foundry equipment to handle ore. Two big ones were recently built in fifty-seven days. Molding equipment can be supplied in equal time. Such equipment is the least drain upon the country's resources that will produce the necessary results.

When a large number of cast steel ships are started and we show our ability to meet the submarine losses and provide means to throw our resources into the struggle, Germany will find that its "last card" has been trumped, and then will begin the struggle of the Hohenzollerns to save what they can out of the wreck.

London Firm to Build Concrete Ships.—Owing to the impossibility of securing either steel or wooden vessels for their fleet of Miramar motor coasters, Messrs. Pollock, Sons & Co., Ltd., London, owners of these vessels, have decided to construct reinforced concrete vessels. The first vessel to be laid down will be 92 feet 4 inches long, 19 feet beam and 10 feet depth, fitted with a 120 brake horsepower Bolinder "M" type engine. The same firm is also about to build reinforced concrete barges of 130 tons capacity.

Cooling of Magazine or Other Enclosed Spaces by Ventilation*

BY S. B. CROSBY

On board some vessels there are magazine spaces or other similarly enclosed spaces which are required to be maintained at a lower temperature than that which prevails in the spaces adjacent to the said enclosed space or magazine.

The decks and bulkheads surrounding the enclosed space are provided with insulation and an adequate ventilation system is installed to supply the air to maintain the specified temperature.

A case will be assumed as follows: Temperature of air in surrounding spaces, 110 degrees F.; temperature on deck, 80 degrees F.; temperature to be maintained inside of inclosed space, 90 degrees F.

It will be necessary first to have a line on the rate of heat transmission through the insulated walls. Tests on cork insulation conducted at the Washington Navy Yard show that with 3-inch cork the transmission of heat per hour, in B. T. U., per square foot per degree difference in temperature is 0.19 B. T. U., while with 4-inch cork it is 0.16 B. T. U. Also the transmission of heat through a 1-inch pipe passing through the bounding walls into a given insulated space is 0.282 B. T. U. per hour per degree difference of temperature, while a 2-inch pipe transmits 0.297 B. T. U., and a 3-inch pipe 0.305 B. T. U., thus showing that the losses through a pipe or other small projection is not necessarily proportionate to the size.

Assume that the loss through pipes, hangers, poor joints, etc., is 10 percent additional, and if this percentage is added to the figures given by the Washington Navy Yard experiments, the transmission of heat per hour through 3-inch cork will be 0.209 B. T. U., and through 4-inch cork 0.176 B. T. U. per square foot per degree difference of temperature, and the total transmission will be:

For 3-inch cork $0.209 \times 20 = 4.18$ B. T. U. per hour = 0.07 B. T. U. per minute per square foot.

For 4-inch cork $0.176 \times 20 = 3.52$ B. T. U. per hour = 0.059 B. T. U. per minute per square foot.

One B. T. U. will raise the temperature of 57.4 cubic feet of dry air 1 degree F. at about 80 degrees temperature, but allowance must be made for the humidity in the air, and it is customary to use 55 cubic feet instead of 57.4 cubic feet, hence 1 B. T. U. will be taken up by each 5.5 cubic feet of air, and with the heat transmission previously given, the amount of incoming air at 80 degrees to be supplied per minute to neutralize radiation through 1 square foot of bulkhead or deck surface will be:

For 3-inch cork $5.5 \times 0.07 = 0.385$ cubic feet.

For 4-inch cork $5.5 \times 0.059 = 0.325$ cubic feet.

The quantities given are the minimum required, and for practical purposes about 15 percent should be allowed for unequal distribution; accordingly, for 3-inch cork it is recommended that 0.44 cubic feet of air be supplied per square foot of radiation, and 0.37 cubic feet for 4-inch cork.

It will also be noted that the use of the 4-inch cork insulation is superior to the 3-inch cork and requires a lesser quantity of air and a smaller ventilating system.

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* From *The Journal of the American Society of Marine Draftsmen.*

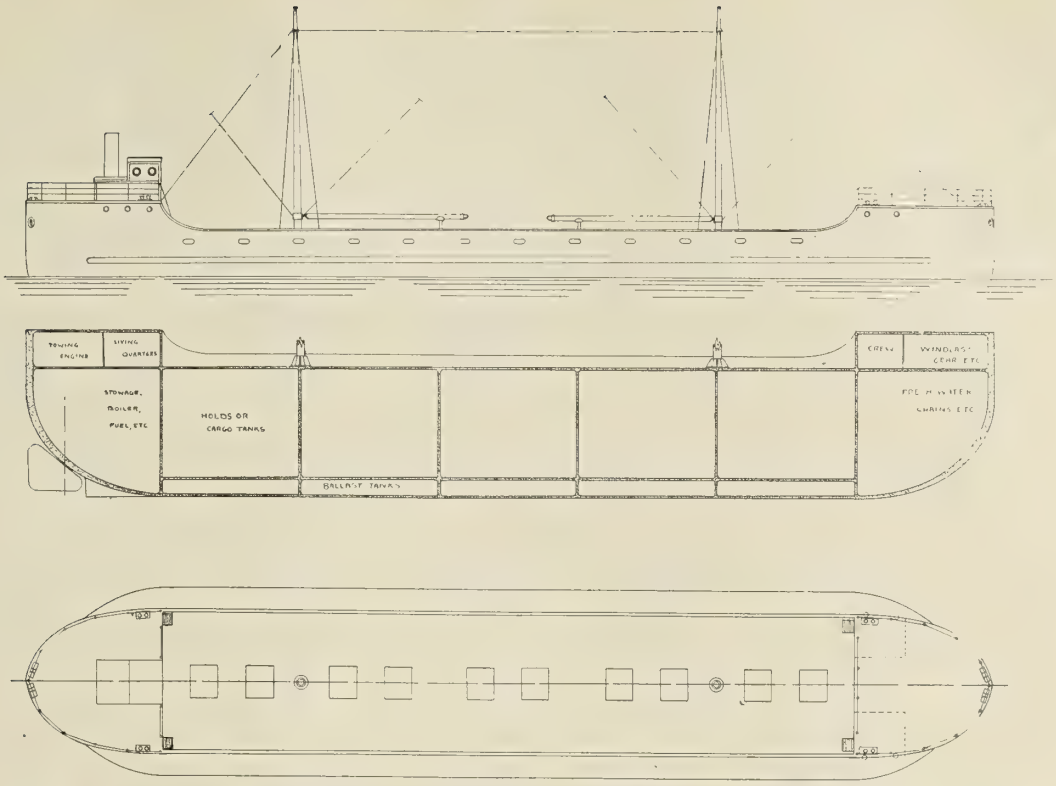


Fig. 1.—Steel Barge with Reinforced Concrete Shell Designed to Carry 1,500 Tons on 17-Foot Draft

Barge Design Involving Bridge Trusses with Reinforced Concrete Shell

Bridge Building Mehods Applied to Barge Construction—Framing Built of Structural Shapes—Shell of Reinforced Concrete or Wood

CLARK & WHITAKER, Inc., 149 Broadway, New York, has a series of designs for bulk freight barges of from 500 to 2,500 tons cargo capacity on which they have applied for patents.

These designs utilize to its full extent the truss principle, instead of the girder on which nearly all ships are built. The truss idea has been used to a certain extent for many years, as in the "hogging frames" of the shallow water boat and in the hogging stringers of some of the older wooden ships, and more recently the center line steel truss in some of the larger wooden schooners.

Truss Principle Utilized

In working out the designs, principles from other brannches of engineering are taken advantage of and the basic idea is to produce a bulk cargo carrier, which can be quickly and comparatively cheaply built, or, rather, manufactured. It was with this idea in mind that they decided to design these barges and employ the bridge truss idea, the trusses carrying all the load and strains and the shell being only a water excluder.

The design shown herewith is for a liquid cargo barge of 1,500 tons, or approximately 10,000 barrels capacity on 17-foot draft. Its dimensions are: length overall, 175 feet; breadth to outside of shell, 34 feet; depth keel to deck, 24 feet.

It will be noted that the fore and aft stresses are carried by two compound vertical trusses, one in each bilge, and that these are also trussed horizontally at top and bottom, forming deck and tank top, and that the transverse bulkheads dividing the hull into watertight compartments are also trussed. These trusses, or the truss as a whole, are very rigid and so proportioned that the tensile strain in any part does not exceed five tons per square inch. This truss or trusses carries all the load except local strains, which are taken care of by the auxiliary frames which carry the skin or envelope. Each frame in itself forms with its bracing another truss against its strain. These are attached to the truss and carry in turn the weight and stresses of the envelope or skin, as the structure of a tall building carries and supports the weight and stresses of its envelope.

Structural Shapes Employed

In order to reduce to a minimum the plant necessary to construct these barges, structural shapes are employed as far as possible with a view to having the steel work fabricated at the mill, knocked down and shipped to the point of erection. With this in view the form of the barge is dead flat for the length of the trusses and for the barge shown, only five frame molds are required. All panels of the trusses can be templeted and repeated, so that the fabricating problem is very simple.

In view of the fact that all strains are carried by the

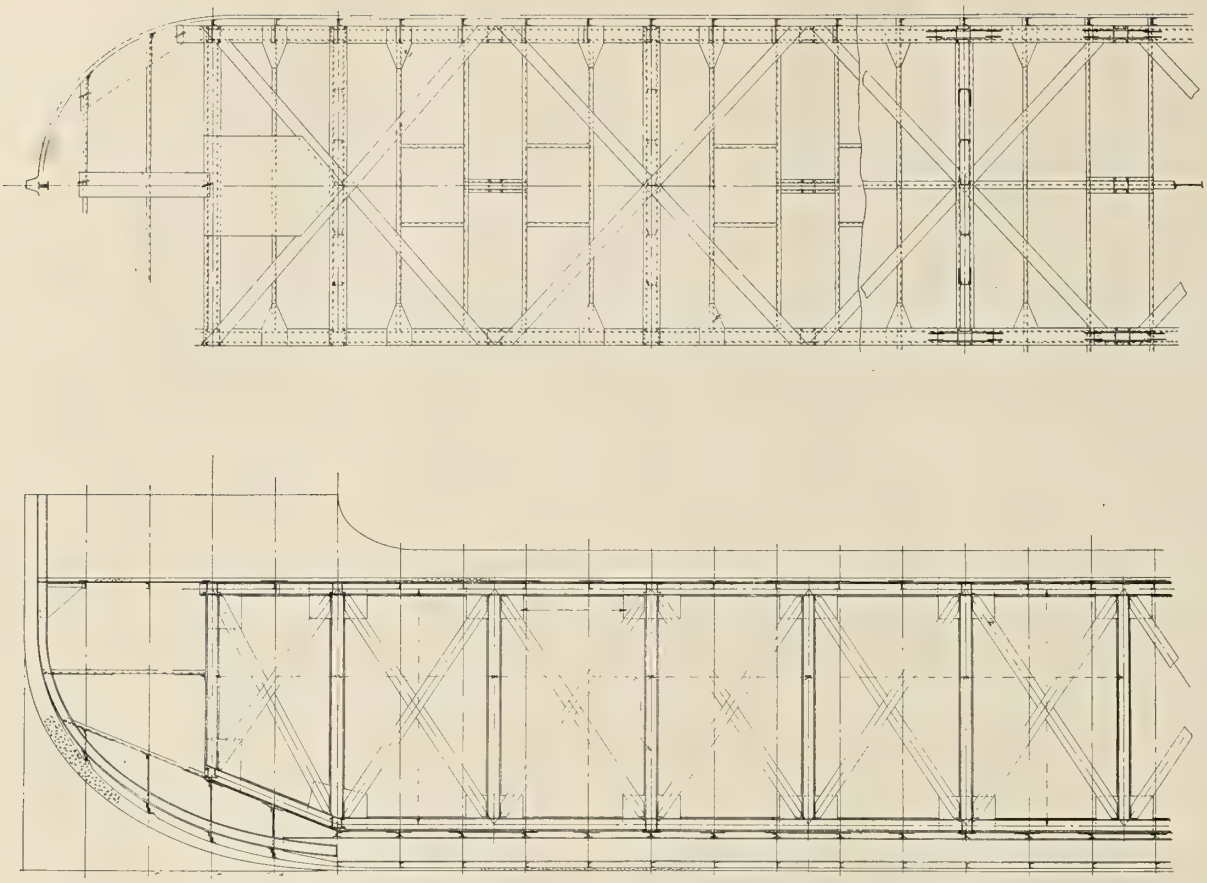


Fig. 2.—Deck and Truss Construction

truss, the importance of the skin or envelope becomes only a question of local strength and watertightness. Any materials having these properties will meet the requirements.

REINFORCED CONCRETE FORMS THE SHELL

Concrete and wood immediately suggest themselves for the purpose. Of the two, concrete apparently has the call, because it can be applied in a fluid condition with a gun, which lends itself to facility of construction, small plant required, and because it is at its best under compression. It has a certain amount of flexibility, greater, in fact, than is required by the rigid backing of the truss. It is easily applied, sets quickly, requires no paint, is noncohesive toredo proof and easily repaired. If properly guarded against blows from docks or bottom, it is practically everlasting.

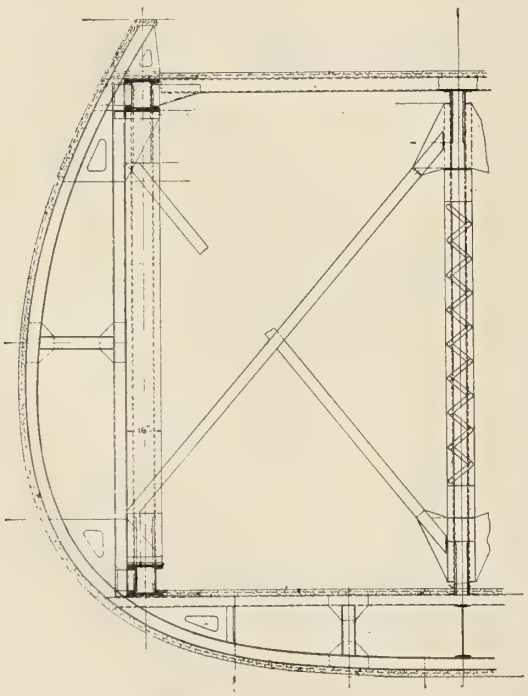


Fig. 3.—Midship Section

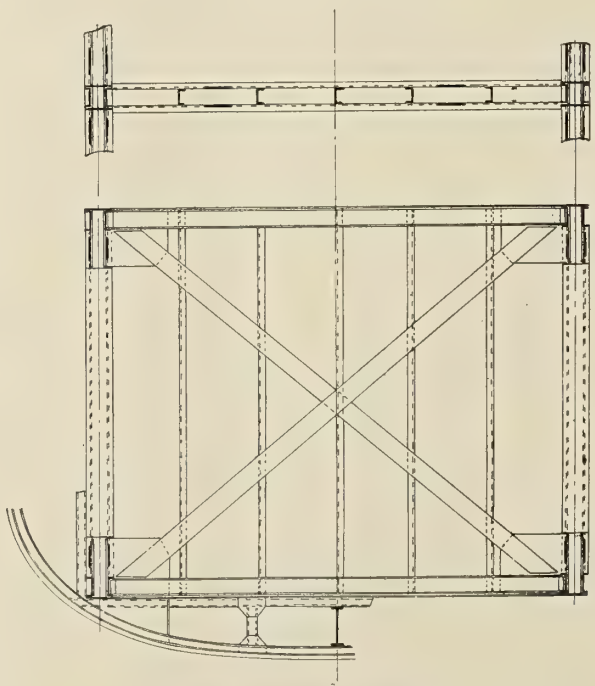


Fig. 4.—Transverse Bulkhead

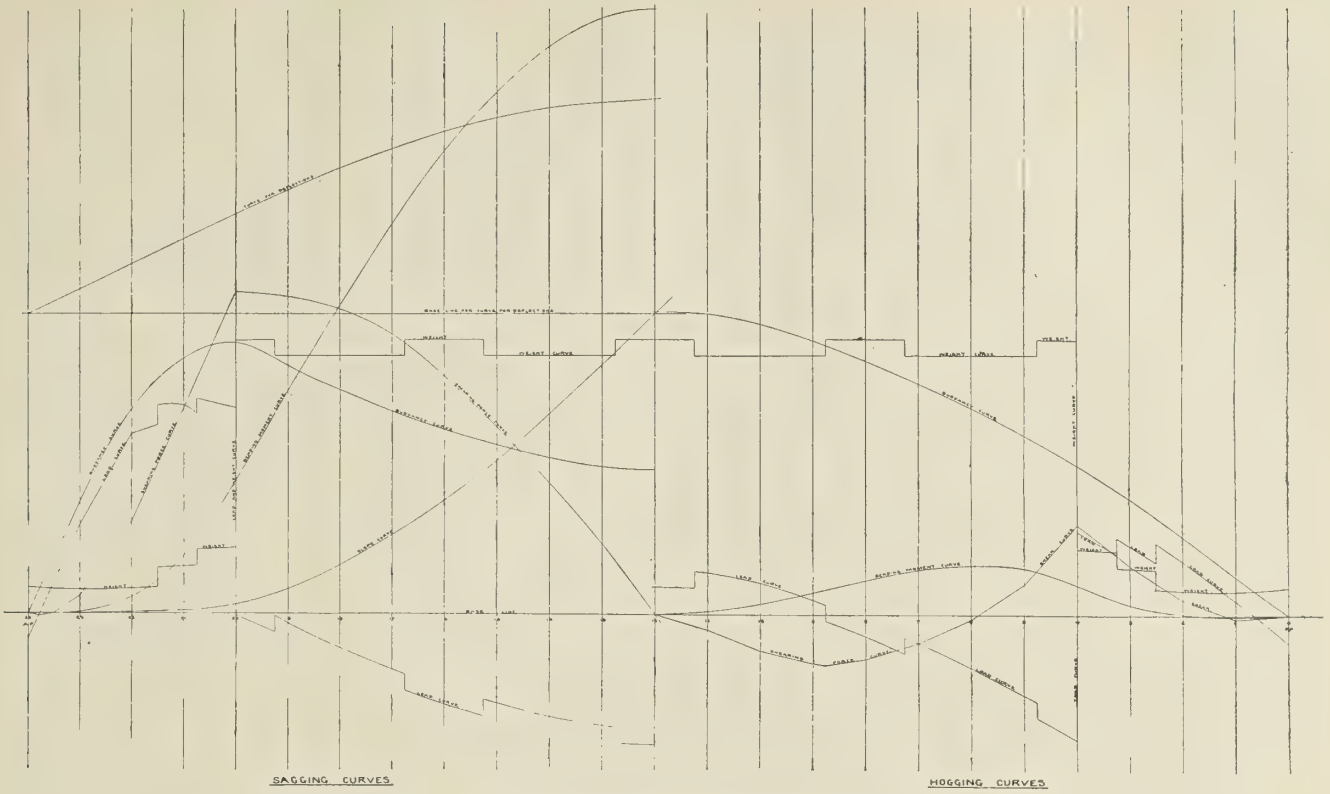


Fig. 5.—Hogging and Sagging Curves

In the design worked out the greatest unsupported area of shell is 10 square feet and no great mass of metal is embedded in concrete exposed to salt water.

The design lends itself to cubical concrete tanks formed by the tank top, the deck, transverse bulkheads and wing bulkheads inside the vertical trusses.

Saving in Steel

In these designs the steel required is practically only 50 percent of that for an all-steel vessel of similar capacity and the total weight of hull only slightly greater than its all-steel counterpart.

It has been found, however, in making calculations for the series, that the steel required to maintain the factor of safety increases very rapidly with the size, which would point to a practical limit of the principle. If it were required to design barges for cargoes other than liquids, the cargo space could be wood-enclosed, reducing the weight somewhat and giving greater cargo capacity, but this under the conditions of to-day would slightly increase the cost.

Welding and Reinforcing by the Electric, Oxy-Acetylene, or Other Processes

Prescribed, by the Board of Supervising Inspectors, United States Government.

All calking edges on internally fired boilers may be reinforced by these processes.

Calking edges of the shells of externally fired boilers, above the fire line only, may be reinforced.

Cracks extending from edge of lap to rivet, except on seams below the fire line in externally fired boilers, may be welded.

Cracks not exceeding 30 inches in length in back connection sheets, wrapper sheets, bottoms of combustion chambers, heads and other stayed surfaces may be repaired by welding.

Where cracks are repaired by welding, holes shall be drilled entirely through the plate at each extreme end of the crack, except in small cracks from rivet to calking edge.

Circumferential or lengthwise cracks not exceeding 16 inches in length in plain or corrugated furnaces may be welded.

Where plates in back sheets of back connections, wrapper sheets of sides and bottoms of back connections of any boilers, side sheets and legs of furnaces and bottoms of furnaces of firebox boilers, and other stayed surfaces are reduced in thickness not exceeding 40 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches in any one plate.

When such reinforcing extends over stays and braces, such stays and braces shall come completely through the reinforcing so as to be plainly visible to the inspectors.

When the corroded portion of stayed or riveted surfaces of the back sheets or wrapper sheets or bottoms of back connections of any boilers, or side sheets and bottom sheets of furnaces or legs of firebox boiler exceeds 300 square inches, the same may be repaired by the removal of the corroded portion and the replacement thereof by a new piece of plate, the edges of the new plate being welded in position.

Staybolts, braces or rivets shall pass through the body of the new plate as before, the area of the new piece not to exceed 24 inches by 24 inches, or 30 inches, in any one direction, the welded edges to be V'd or beveled along the joint prior to welding.

Where plates of shells and other parts of internally fired boilers subject to tensile strain are reduced in thickness by corrosion not to exceed 25 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches.

Where calking edges and laps have been reinforced,

local inspectors shall require the rivets to be cut out and redriven if they find by inspection that it is necessary.

No welding shall be allowed in cracks in the shell plates or other plates subject to tensile strain.

Cracks extending through rivet holes in single-riveted or double-riveted seams in stayed surfaces of back connections of any boilers or side sheets of legs or bottoms of firebox boilers which are stayed surfaces may be welded up to a length of 6 feet exclusive of rivet holes.

Where cracks extend through rivet holes in stayed surfaces, the piece extending from the rivet to the edge of the lap may be removed where convenient to do so, and the place where the piece has been removed may be replaced by being built up and reinforced by either of these processes.

Welding Leaky Staybolts

Where leaks develop around staybolts and the staybolts are otherwise intact, the nuts may be removed from the ends of the staybolts and the staybolts may be welded into the shell by welding a beveled collar or ring around the staybolt. The width and depth of such collar shall equal one-half of the diameter of the staybolt. In all such cases of applying welding rings or collars around staybolts, the material shall be hammered while in a glowing state as it is applied.

In all cases where metal is deposited on stayed surfaces, the operator shall hammer, when practicable, the deposited metal while it is in a glowing state.

No repair work by any welding process shall be allowed until coupons showing the character of the work proposed to be done by the applicant have been tested and submitted, together with an explanation and report of the test, to the local inspectors of the district where the work is being done. The local inspectors shall then satisfy themselves whether or not such process can be used with safety on the boilers of steam vessels.

In every case where repairs are to be made by these processes on the boilers of steam vessels subject to the inspection of this service, the parties making the repairs are required to notify the office of the local inspectors, in writing, giving a full detailed description of the repairs to be made, the location of the vessel, and the time the repairs are to be begun, so that inspection may be had, if practicable, prior to and during the time the work is being done.

The application for permission to use this process on boiler repairs of any particular vessel implies a guaranty on the part of the applicant that the work shall, in material, flux and workmanship, be equal to that of the samples furnished.

Welding Wrought or Cast Steel Parts

Cracks in wrought iron or wrought steel headers, and cracks or sand holes in cast steel, semi-steel, ferro-steel, malleable iron or cast iron headers, manifolds, crosses, tees and ells may be repaired by welding cracks or flowing metal into sand holes. Such repaired material other than headers and manifolds shall be subjected to a hydrostatic test of three and one-half times the working pressure after such repairs are made. Reinforcing by building up of any of the above-mentioned articles other than headers shall not be allowed.

When crown-bar bolts have deteriorated or wasted away at top of combustion chamber under the crown bars, such deterioration not to exceed 25 percent of the original diameter of the bolt, such bolts may be built up or reinforced by any process of autogenous welding.

Where tube sheets of boilers have deteriorated not to exceed 25 percent of their original thickness, or where cracks have developed in tube sheets, the same may be reinforced and repaired by any process of autogenous welding, and the beading on the ends of tubes may be welded to the tube sheets by the same process. (Secs. 4405, 4418, R. S.)

Chart for Staying Flat Surface of Boilers According to Lloyd's Rules

BY A. F. MENZIES

Most of the formulas used in boiler design are used only once in connection with any particular design. Those for flat surfaces, however, are used several times. In order to lessen the labor involved in figuring out each variation of the flat surfaces, the accompanying chart has been prepared.

The chart is based on Lloyd's Rules for the construction of marine boilers, and includes all the ordinarily used constants. To illustrate its use: Suppose the steam space stays come in conveniently at 18-inch centers, stays to be secured with double nuts and outside washers which are to be two-thirds the pitch in diameter and one-half the thickness of the end plate, the working pressure being 180 pounds per square inch.

Start at the top of the chart at 18-inch pitch and drop vertically to the correct constant, which, in this case, is 185 for steel plates. From the intersection with this constant line run horizontally to the 180-pound pressure line. From this intersection drop vertically to the plate thickness at the bottom of the chart, which will be found between 1 3/32 inch and 1⅛ inch. The latter thickness will, of course, be used. The dotted line illustrates the above example.

By reversing the operation the chart can be used to find the maximum stay spacing, which can be used with any given plate thickness, method of securing the stays and working pressure.

In Busy Times

Nearly all shipbuilders are working their machine shops both day and night; this calls for a class of machinists who must be able to pick up the other fellow's work at any point of its progress. It may be in the midst of a finishing cut or a half set up job in the machine. When the shift whistle blows, the day man must pick up the night man's work, and vice-versa. That a great deal of work is not spoiled, or that a considerable amount of time is not lost in making this shift, speaks well for the skill of the class of machinists that are turning out the varied class of work which comprise the component parts of many types of marine engines and their auxiliary machinery.

When mistakes are made or some work spoiled it is rather difficult to place the blame. The following illustrates this: A large tail shaft was being machined; the night man had roughed out the last cut and left just enough for finish—it was the taper end of the shaft to which the propeller is fitted. The day man relieved him and made the finish cut. When the template of the bore of the propeller was tried it was found that the shaft was out 1/16 inch in the taper. As the propeller had already been bored, one of the two had to be condemned, and of the two, the inspector condemned the shaft. The day man claimed the night man had told him the taper attachment was set all right for the correct taper. The night man claimed he left a big roughing cut and had not said that the taper was set correctly. Neither of the men was discharged.

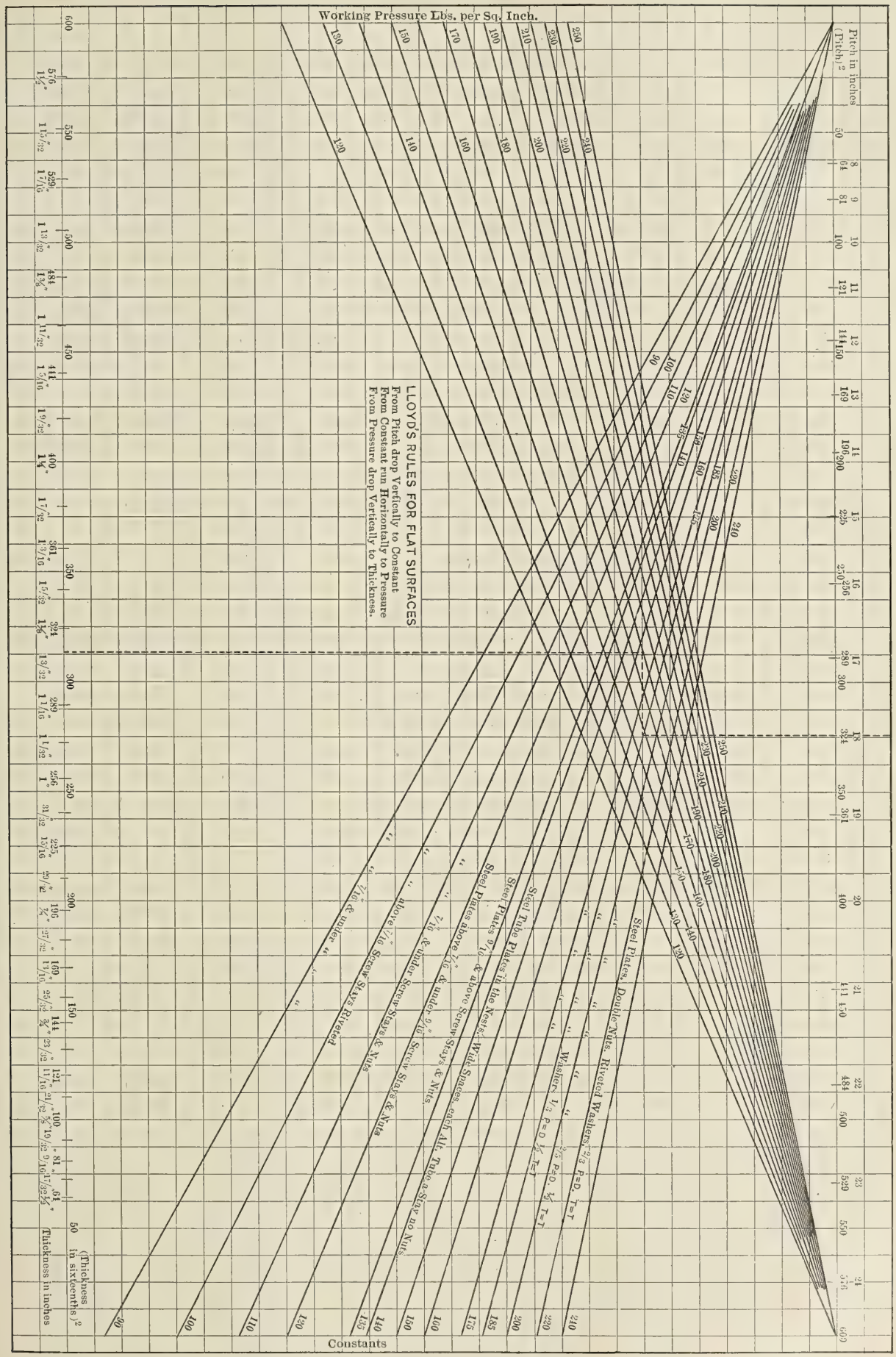


Chart for Designing Staying for Flat Surfaces of Boilers According to Lloyd's Rules

Why Is a Concrete Ship?

Advice from a Veteran Ship Draftsman as to the Design of a Reinforced Concrete Ship

MORE overtime! What is left of our office force has again gone stale. The "bush leagues" have drawn heavily on us and structural men and conscription dodgers that have been taken in avail but little. In the vernacular of baseball, we are known as the major league, and because of our good standing and organization many of our men have been coaxed away and made pitchers in these bush leagues. More work and less men—hence the overtime. The yard is close on our heels and there is more or less confusion.

Old Mac had grown irritable until he became genuinely tired out. He is now more or less indifferent, and I often see him gazing out of the window—day dreaming. Noticing this to-day, I suggested as I passed that I would give him a "penny for his thoughts."

"You see that switch engine over there?" he answered. "Well, every time it comes around here and blows its whistle I get to dreaming. Most of these dreams are connected with some of my experiences up North. For some time I could not figure out what the whistle had to do with it, until I remembered how, when I was convalescing from an operation for appendicitis and could not sleep very well, I used to mark the passing of the small hours of the morning by the whistle of a freight train that would come along and blow just as it got out of the timber and into the clearing in front of the hospital. This switch engine is the same one that pulled that freight, or it has the same whistle, and I am just about as "pepless" as I was when that "doc" up there gave me a knockout with some of his nasty ether. I am tired out. My thinker, unguarded and deserted by an ordinarily alert interest in surroundings, is exposed to some such remote influence as that whistle, which has uncovered experiences of no importance and long ago forgotten."

"How about licorice powder, Mac?" I asked.

"No good. It has lost its effect. 'Johnny Walker' helps out some, but I think that the only way is to have that whistle tuned up or down enough to keep its waves out of my wireless. Some day not very far off I am not going to show up here, but instead I am going to beat it up into the timber and fish. Do you like to fish?"

"Not particularly, Mac," I answered.

"Well, then, you have not a philosophical mind. No use to talk any more to you."

That evening after dinner and when the disinclination to work is strongest, young Stevens went over to Mac's board and gave him a letter that had been directed to Robert Duncan and was now marked across the front with red ink, "Killed at the front—Major W. S. Return to sender." Bob Duncan was a fine, manly young fellow in the loft and a close friend of Mac and Stevens. A sister in the old country had written him a rather caustic letter, in which she referred to him as a "slacker," and he promptly enlisted in a company of Scotch engineers. The returned letter was one that had been sent in answer to the first of his from somewhere in France. Bob had come into the office often before he went away and was a general favorite. Mac was depressed and did not say much until Stevens asked him if he would show him how to lay out a concrete ship.

"There ain't no such animal," Mac replied.

"'Old Man of the Sea' says they build them in Norway and that a Frenchman built one in France in '49' that is still afloat."

"What has 'Old Man of the Sea' got to do with concrete ships? Is he going to try and build one?" asked Mac.

"Yes; he is naval architect for a new company that is made up mostly of concrete contractors around town."

"Where do you come in on it?"

"'Old Man of the Sea' wants me to draw up the plans. He says he always figured Tek to be the brainiest man in the office, so he started him in on the job. Tek has been a month figuring out the shape of a wave so that he can calculate the hogging and sagging strains. 'Old Man of the Sea' can't wait any longer and the concrete men want the plans. He wants me to help Tek out. Tek is too deep for me and I will have to go it alone, I guess, or give it up."

"See it through. You can get by 'Old Man of the Sea' and those strong-backed mud-mixing friends of his all right. When did all this happen?"

"Tex has been working on it a month."

The Concrete Ship

"Well! What do you know about that 'Old Man of the Sea'? You have got to give the devil his due, though. Skinning those Swedes. Naval architect! Pretty slick nut after all, isn't he? What is he going to tackle first—a submarine or a destroyer?"

"A 250-foot coaster."

"That is reasonable. Is he going to pay you for your trouble?"

"He said he would."

"How much?"

"He did not say just how much."

"Well, now; the first thing for you to do is to have that definitely understood. You are a draftsman—ship draftsman—not an angel for a bunch of nuts. Don't be a sucker! These things don't come often, so get double time—cash. Get your money at the start, the way the real estaters do. Remember, the way of the inventor is hard. The bookkeeper told me the other day that Dun and Bradstreet's man had told him that only 2 percent of business ventures are successful, and that, on the average, four men fail before the fifth man makes a go of it. 'Old Man of the Sea,' if he is lucky enough to be among the 2 percent, will have to go broke four times before he makes good. Some handicap!"

"Don't you think a concrete ship is possible?"

"Yes, it is possible, but a costly experiment, though. You are a draftsman—not a promoter—and $250,000 is more than you or I can lose."

"What will I do, then?"

"Tell 'Old Man of the Sea' you will do the job for him for $1 an hour. That is cheap. Labor is paid first in this State; don't work for a lump sum, which might be considered as an open account payable in sixty days or never. I remember once how I took a chance on half the profit on a propeller design, and came near dividing a loss. The other fellow kept the account.

"Well, the first thing to do is to make up an outboard profile. Go down to the vault and select something near what he wants. Copy it bodily. Show in some wet water, a stockless anchor, some fat lifeboats, a couple of

masts and a wireless; a waving flag, a searchlight with numerous expanding rays of light shining out of it; shade up the windows; show in the rail and stanchions, etc., and, above all else, make an alluring title having 'Old Man of the Sea's' real name the most important thing in it. Designed by ————————, naval architect. Find out his middle name and any fancied title he may have. Put them in also. Put on a fancy border. Call the ship the *Ferro Concrete.*

"Get him a blue print and tell him that if that is what he wants you will go ahead with the lines and midship section. Keep the tracing until he pays you the first instalment. The minute he sees it he will want a lot of prints to hang up home and around town in the promoter's windows."

"Then what?"

"Wait until he gets all fussed up and begins to stretch his hatband. Wait until his friends want to know how much the *Ferro Concreto* is going to cost; how much she will carry, and how fast she will travel. Then get out the lines and the midship section."

"How will I do that?"

"Get out a section for a steel vessel of the same size. Then make an equivalent section for the reinforced concrete ship. Don't bother with any hogging or sagging calculations. Don't bother with any equivalent girder considerations. These classification societies did that long ago; got the decimal point wrong, missed the mark, corrected their sights, got the range and now hit the mark with regularity. You can lean on them to advantage, and it may help 'Old Man of the Sea' to get insurance, if he ever gets his ship into the water."

"But, how will I make this equivalent concrete midship section?"

Equivalent Concrete Midship Section

"Your concrete ship will have to have about the same area of reinforcing steel in the section as the steel ship has steel area. You can get along with less, come to think about it, because the efficiency of joining the reinforcing bars is unity, while all the longitudinal strength members in a steel ship are cut and weakened by a line of non-watertight rivet holes. A plate butt is only 60-80 percent efficient, and a ¾-inch rivet hole cuts out 25 percent of a 3-inch angle flange. The disposition of the reinforcing steel in the concrete ship should be about the same as it is in the steel ship."

"Don't the concrete help at all?"

"Only in compression. A ship at sea is subjected alternately to hogging and sagging strains as she passes over the crest of a wave. The longitudinal reinforcing then has to resist tension (as its worst condition) alone and without the help of the concrete, because when the reinforcement is stressed the concrete is cracked in an infinite number of minute cracks—pieces of concrete strung on the reinforcing, like doughnuts on a string.

"A job like this is an experiment, and the best way would be to distribute the reinforcing steel in about the same location as it is in the steel ship, and having about 80 percent of the area of the steel plates and shapes in the steel section.

"The concrete in the shell is not doing much good as a longitudinal strength member, and you can't work it much less than about 4 inches thick, so that the best way will be to figure your transverse strength members on a wide spacing. Sort of half way between a transverse framed ship and an Isherwood ship. Go and get one of those concrete floor slab hand-books that the reinforcing and expanded metal fellows give away and determine upon a frame spacing that will accord with the thickness of your concrete shell and the water pressure per square foot due to the depth of water submersion, and which in this case will be what they call floor load. At a guess, I would say that this might be about 4 feet. Work out the deck in the same way as for a floor slab.

"Make the concrete frame equal to the steel frames in the 4-foot space, or whatever this space works out to be. Do the same with the beams.

"The area of reinforcing steel in your longitudinals and stringers can be reduced about 20 percent below that of the steel ship, because these members are no longer intercostal, the concrete at the intersection with the floors making them as one piece. For this reason the intercostals should be as heavy and stiff as the frames."

"How about the mixture of the cement? Tek says that this is very important, and 'Old Man of the Sea' says he is going to use a secret German compound that will strengthen and waterproof the concrete."

Mixture of the Concrete

"More bunk! Mud is mud. Where is 'Old Man of the Sea' going to get his compound? Maybe the Germans will send him over a load in a submarine. Say, you know that city chemist who comes over in the evenings to play chess? Well, he tests all the cement, concrete, etc., for the city, and is in a position to judge pretty well the merits of all such claims. He tells me that the best concrete is the concrete that is the densest. It is more nearly waterproof and has the greatest resistance to shearing. Concrete in compression fails by shearing, you know. It slides off at an angle to the vertical. Now, he says that to make concrete dense all that is necessary is properly to grade the rock, gravel, sand and cement. He determines this by what he calls a mechanical analysis of the materials to be used. He runs them through screens of different sizes, and in this way finds out how to fill the voids or spaces in the rock with gravel, in the gravel with sand (sometimes there are two kinds or sizes of sand), and in the sand with cement. Sometimes he puts hydrated lime in to fill up the cement voids. This, perhaps, is 'Old Man of the Sea's' German magic. He says that this is good concrete and that about all these compound men do in the way of waterproofing is to show some botcher how to make fair concrete, getting their pay in the sale of some compound—secret and mysterious. 'Old Man of the Sea' had better get this fellow to grade his aggregate for him."

"Everybody says a concrete ship will be too rigid and will not be elastic. Is that so?"

"No; reinforced concrete is elastic, if well proportioned. High tensile steel and concrete have about the same coefficient of elasticity. When somebody was figuring out coefficients of elasticity he noticed that these two were the same nearly, and this suggested the combination. Sure, a concrete ship will be elastic. That is not the thing to be pessimistic about, however.

Hull Fittings Cause for Worry

"What would worry me would be the development of the thousand and one details that come up in the finishing up of a ship, such as watertight doors in bulkheads, openings through the shell, such as sea stools, air ports, bollard, belt and cleat fastenings, foundations for main and auxiliary machinery, rail stanchions, rudder and sternpost connections, etc. How about fresh water and oil tank, bulwarks and rigging details? All these things must be worked out correctly before the work is started, because the mud must be poured as nearly continuously as possible. A leaky sea stool or a loose pintle connection

can only be reached in a dry-dock, and concrete once set is a refractory thing to work. You know how hard a time they have keeping lights in sidewalks. In a steel ship a few drilled holes and a rivet or two and a dependable job is the result.

"Your ship will be heavy, too. You will have to figure this weight roughly before you can finish up the lines."

Old Mac was interrupted at this point by a bark, followed by one agonized howl. We all recognized the bark as that of "Bob," the dog that belongs to us all, but that nobody owns. He lives from lunch contributions at noontime from the men around the yard. He has a route, and his numerous friends keep him well fed.

Sunday is a hard day for "Bob," because there is little or no lunch. This very morning, Monday, having had but little to eat yesterday, he came into the office begging. Casey had brought some tomales for his lunch and had given "Bob" one of them. At first he was shy, but he finally gulped it down, and soon, feeling the warming stimulus of the chili, with head and tail erect went on his beat around the yard.

I had never heard "Bob" howl before. He had been in numerous fights and in lots of trouble, but I had never heard him howl. We all looked out of the window. There was a crowd around the yard truck, which had stopped in the street in front of the office. Sport, another dog and a bosom friend of "Bob," had hold of "Bob's" collar with his teeth, and was trying to pull him out from under the back wheel of the truck. The driver was rattled. He had stalled his engine. To get the gear in the reverse he had, after starting the engine again, to go a little more ahead. "Bob" was finally gotten out, but he was so badly maimed that his friend the policeman had to perform an unpleasant duty and put him out of his misery.

Old Mac walked over and put on his hat and coat. He was upset, and went out without saying a word. I can imagine what Mac saw, perhaps, in that truck and its ruthless driver. Two "Bobs" at one time is a terrible reminder of what is going on over on the other side of the world.

Yes, Mac went fishing.

Steamboat-Inspection Rules Amended

The Steamboat Inspection Service has issued a circular letter dated August 24, 1917, addressed to inspectors of the service, boiler manufacturers, manufacturers of boiler plate, and steamboat companies, containing amendments of the general rules and regulations of the Board of Supervising Inspectors, and approval of vessel equipment and boilers, as adopted by the Executive Committee of the Board at a meeting held from August 15 to 22, inclusive, 1917.

Tensile Strength, Steel Boiler Plates

The restrictions relating to tensile strength required for steel boiler plates as contained in amended rules were struck out of the rules and regulations by the following amendment:

Section 5 of Rule I, General Rules and Regulations, all classes, reading as follows, was struck out:

"The tensile strength determined by the tests shall be not less than 58,000 pounds per square inch of section, nor more than 73,000 pounds per square inch of section, and the elongation measured in a gage length of 8 inches shall be not less than 20 percent."

And the following paragraph was substituted therefor:

"All steel plates tested shall show an elongation of at least 20 percent measured in a gage length of 8 inches."

Area of Segment of Boiler Head—Flat-Seat Safety Valve

The following paragraph relating to determining the area of segment of boiler head was struck out:

"The area of the segment of a head to be stayed shall be that surface contained within a line drawn 3 inches from the inner circle of the head and 2 inches from the tubes or flues."

The following rule for determining the discharge capacity of a flat-seat safety valve was adopted:

"The discharge capacity of a flat-seat valve shall be one and four-tenths times that allowed for a bevel-seat valve."

License Requirements Rescinded

Owing to the excessive demands for officers of merchant vessels, created by the exigencies of the war, experience and examination requirements for license as master, mate, pilot and engineer of merchant vessels, as contained in sections 20, 21, 22, 23, 26, 31 and 32 of Rule V, General Rules and Regulations, both in Great Lakes and river rules, were struck out, and the issue of licenses to officers of vessels within the classifications referred to was left by rule to the judgment and discretion of the local inspectors, as vested in them by law, the sufficiency of the experience of an applicant for license to be determined by the local inspectors when applicant applies for examination for license.

Flanges Made by Bethlehem Steel Company

The following resolution approving dimensions of flanges made by the Bethlehem Steel Company was adopted:

"*Resolved,* That the standard dimensions of cast iron, composition and wrought steel flanges as prepared and submitted to the committee by the Bethlehem Steel Company for use by the shipbuilding plants of that company be approved as meeting the requirements of the general rules and regulations relating to flanges. Copies of the blue prints covering drawings and dimensions as submitted to the committee must be furnished by the Bethlehem Steel Company to each supervising inspector and each board of local inspectors of the district in which the plants of the company may be located."

Vessel Equipment and Pipe Boilers Approved

The following-described vessel equipment was approved:

Childs fire extinguisher, presented by O. J. Childs, Utica, N. Y.

A B C life raft, presented by the Welin Marine Equipment Company, Long Island City, N. Y.

Universal ilanasilk, ring life buoy, presented by Robinson-Roders Company, Newark, N. J.

Universal ilanasilk, jacket life preserver, presented by Robinson-Roders Company, Newark, N. J.

Under the provisions of Section 4429, R. S., the following-described pipe boilers were approved:

Emergency Fleet Corporation's standard watertube boiler, presented by the Emergency Fleet Corporation, Washington, D. C.

Foster marine boiler, presented by the Power Specialty Company, New York, N. Y.

Meier boiler and Meier superheater, presented by the Heine Safety Boiler Company, Phœnixville, Pa.

The action of the Executive Committee received the approval of the Secretary of Commerce on August 22, 1917, under the provisions of Sections 4405 and 4491, Revised Statutes.

Notes on Rudders

Stresses in Rudder Stock—Rudder Area—Formulæ Used

BY CARL E. PETERSEN*

RUDDERS are of two kinds, *i. e.*, ordinary or unbalanced and balanced rudders. An ordinary rudder is one in which the whole of the area is abaft the axis of the pintles and rudder-head. In balanced rudders some of the area is forward of the rudder-head axis, for the purpose of reducing or eliminating the twisting moment about the axis.

The principal parts of the rudder which require calculations for strength usually are the rudder head, the main piece, the rudder arms and the rudder pintles. The various classification societies and handbooks give empirical formulæ and tables for proportioning rudder parts. There are, however, great differences in the results obtained by the use of the various formulæ available. The best method of estimating the stresses in the rudder stock is to calculate the pressure on the rudder blade and its moment about the axis of the rudder stock by means of Joessel's or Beaufoy's formulæ.

The stresses on the stock, due to the shock of the waves against the rudder blade, may be five to six times that due to putting the rudder hard over in still water. (S. S. *British Prince*, the maximum pressure on gear to put rudder hard over was 5.6 tons at 13 knots' speed in calm, while indicator springs were broken during storm showing at least 30 tons pressure.)

Calculations should be made for statical stresses and a suitable factor of safety used to cover any stress that is likely to occur.

Pressure Formulæ

Joessel's formula for the normal pressure on flat rectangular plates moving through water is:

$$P = 1.622 \left(\frac{\sin \Theta}{0.39 + 0.61 \sin \Theta} - \frac{w}{2g} \right) A V^2 \qquad (1)$$

$$x = (0.195 + 0.305 \sin \Theta)\, B. \qquad (2)$$

where

P = normal pressure on plate in pounds.
A = area of plate in square feet.
V = velocity of current in feet per second.
Θ = inclination of plate to direction of current.
w = weight of cubic foot of water.
g = acceleration due to gravity.
B = breadth of rudder.
x = distance of center of pressure from forward edge of plate.

For V in knots (6080 feet); $w = 64$ pounds per cubic feet; $g = 32.16$ feet per second—equation (1) then becomes:

$$P = 4.6\, A V^2 \frac{\sin \Theta}{0.39 + 0.61 \sin \Theta}$$

and for $\Theta = 35$ degrees, $\sin \Theta = 0.5736$.
$P = 3.565\, A V^2$, say $3.57\, A V^2$.
$x = 0.368\, B$, say $0.37\, B$.

In using Joessel's formula we must apply a reduction coefficient for reasons explained later.

Beaufoy's formula for the normal pressure on flat rectangular plates moving through water is:

$$P = 1.12\, A V^2 \sin \Theta,$$

where the symbols have the same meaning as above. For V in knots (6080 feet)—

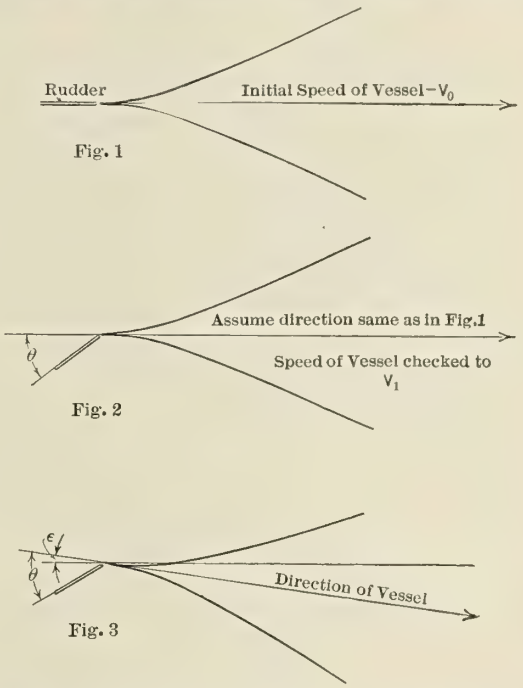
$$P = 3.19\, A V^2 \sin \Theta,$$

and for

$\Theta = 35$ degrees, $\sin \Theta = 0.5736$.
$P = 1.83\, A V^2$.

Beaufoy's formula agrees fairly well with the results obtained from the various actual rudder experiments. It has been used by the British Admiralty for many years in rudder calculations.

The Joessel formula gives too large pressure values for two reasons—(1) Assuming that at the end of the time used in swinging the rudder the ship would not have changed her course, the final speed V_1 in the direction of the keel would be less than the initial speed V_0, on account of the component of the additional resistance of the rudder in the direction of the keel. (See Fig. 2.)



Figs. 1-3.—Effect on Vessel of Movement of Rudder

(2) At the end of this period the ship has acquired an angular velocity at right angles to the keel which diminishes the angle of incidence of the stream lines on the rudder blade by a certain angle ϵ, and consequently the final moment tending to return the rudder to a fore-and-aft plane. (See Fig. 3.)

Therefore the ratio of the actual final moment tending to return the rudder to a fore-and-aft plane to the moment given by Joessel's formula is:

$$C = \frac{V_1^2}{V_0^2} \cdot \frac{\sin (\Theta - \epsilon)}{\sin (\Theta)} = \text{coefficient of reduction.}$$

The values of the reduction coefficient C must be chosen by judgment from the experimental data available on

* Junior member Society of Naval Architects and Marine Engineers.

other ships. However, approximate values may vary from about 0.50 for a small high-speed vessel to about 0.80 for a large slow one.

In screw vessels, when going ahead, the velocity of the water past the rudder is increased due to the slip and may be taken to be:

$$\frac{\text{speed of vessel}}{1 - \text{slip}}.$$

United States Navy practice is to take the augmented speed at 20 percent, while the British Admiralty uses 15 percent in all cases.

Single-screw vessels are more favorable to steering than are the ordinary twin-screw vessels fitted with one rudder, due to the action of the propeller. In sailing vessels the velocity of the water past the rudder is reduced

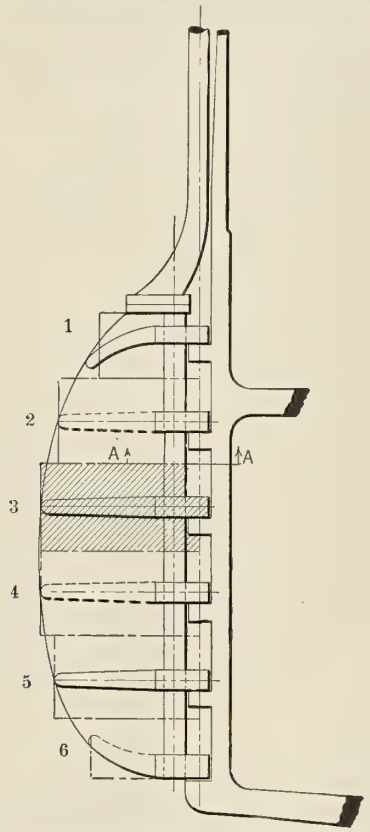


Fig. 4.—Distribution of Pressure on Ordinary Rudder

on account of the frictional wake, which may be taken as 10 percent. Deadwood and full sterns are unfavorable to good turning. In any case the water should have a clean run past the rudder.

Area

Values of area of rudder as a percentage of the immersed longitudinal plane—

Fast ocean liners	1.70
Freighters	1.65 to 2.00
Large naval vessels	2.00 to 2.60
Moderate-sized naval vessels, destroyers, etc.	3.00

In general the percentage increases inversely as the size or speed of the vessel.

Where steam-gearing gears are fitted, with the exception of very slow vessels, any deficiency in rudder area is scarcely noticeable, as the rudder is quickly thrown over to a greater angle than would be necessary if the rudder had the proper area.

As regards shape, for a given area and pressure, a deep, narrow rudder when using moderate angles of helm gives a smaller twisting moment, consequently less power for operating the rudder and a smaller rudder head required than in a wide shallow one. Also the pressure for a given area will be greater for a narrow, deep rudder than for a broad, shallow one. The lower portion of the rudder is more effective than the upper portion.

Rudder area is less in merchant ships than in warships, as there is not the same necessity for large maneuvering powers as in naval vessels. Broader and shallower rudders are used in battleships so as to keep the whole of the steering gear below the waterline for protection.

Stresses

In ordinary rudders, as shown in Fig. 4, where the pressure on the rudder is distributed over so many pintles, the bending moment on the rudder stock is small and practically negligible, and the rudder stock is calculated to resist a torsional stress.

The formula for the twisting moment on the rudder stock is:

$$M_t = f_s Z_p,$$

where Z_p is the polar modulus of the section and f_s is the safe skin stress. Substituting Z_p for its equivalent value for a solid circular section we get:

$$M_t = \frac{f_s \pi D^3}{16},$$

whence

$$D = 1.72 \sqrt[3]{\frac{M_t}{f_s}}$$

Allowable stress on steel stocks of 7,500 pounds per square inch is a reasonable figure, 5,000 pounds per square inch for wrought iron, and the stress on ordinary cast steel rudders should not exceed 10,000 pounds per square inch.

For small, high-speed vessels, such as torpedo boats, fast yachts, etc., a larger value of f_s may be used, say 10,000 for steel and 8,000 for wrought iron, owing to the fact that while the stock is calculated for the rudder at maximum angle and maximum speed, such a condition would never be realized except in smooth water.

Taking f_s at 7,500 pounds per square inch,

$$D = 0.088 \sqrt[3]{M},$$

and at 5,000 pounds per square inch

$$D = 0.1 \sqrt[3]{M}.$$

In the case of a rudder supported only by the stock, *i. e.*, the head fixed and supported at the bottom, the rudder stock should be calculated to resist the combined bending and twisting moments. Assuming that the pressure on the rudder is uniform per unit of depth, it may be shown that the bending moment at the rudder head is

$$\frac{P D}{8},$$

where P is the total pressure on the rudder and D is the depth. The equivalent twisting moment which would produce the same intensity of shear stress as the combined bending and twisting is

$$M + \sqrt{M^2 + T^2}$$

where M is the bending moment and T is the twisting moment.

The twisting moment at any section (A-A) of rudder main-piece is simply the sum of the twisting moments 3, 4, 5 and 6. (See Fig. 4.)

The arms supporting the single plate should be proportioned somewhat to resist the bending moment about the

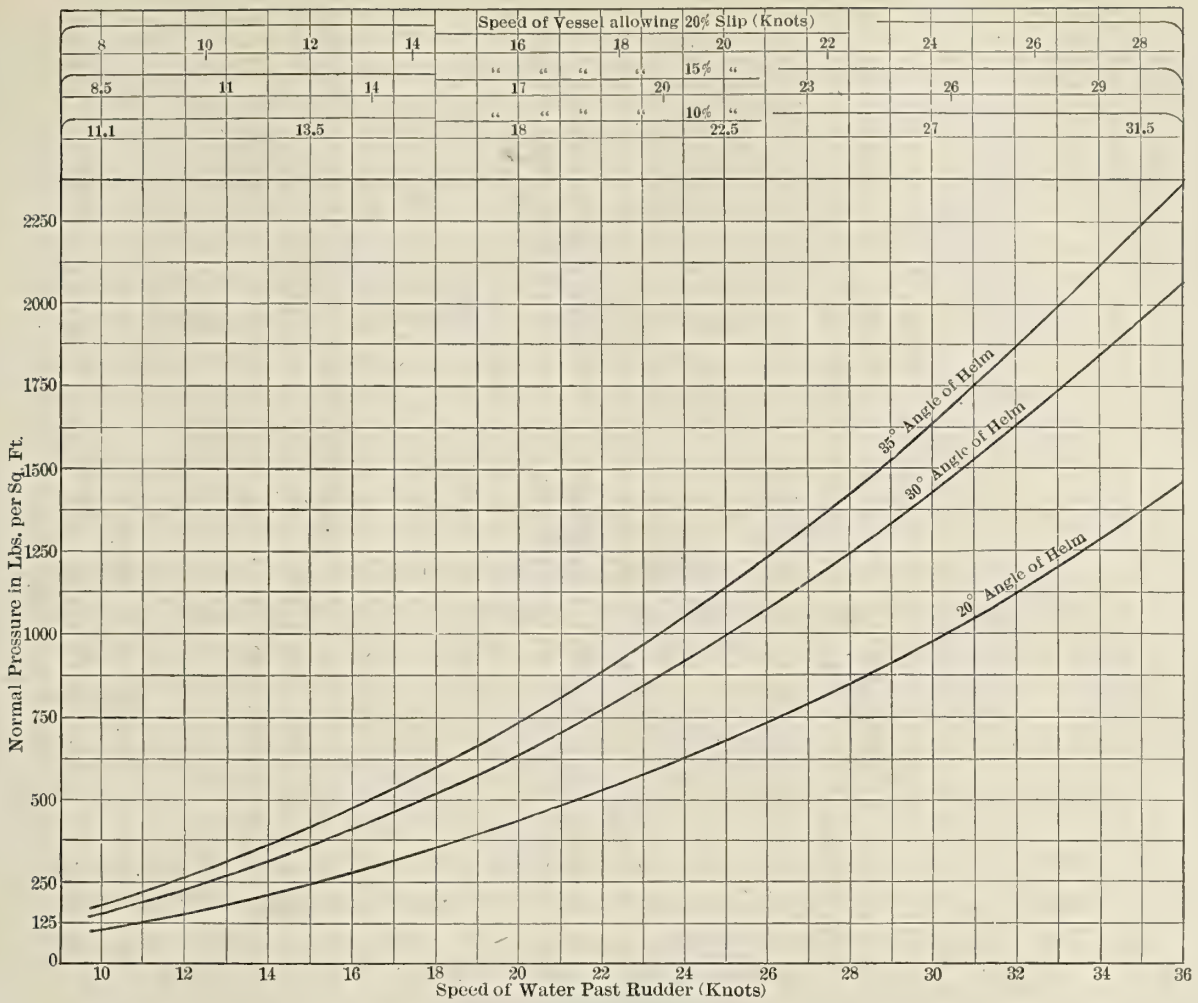


Fig. 5.—Chart Showing Pressure on Rudder at Various Speeds with Helm at Different Angles

axis of the pintles, but in all cases the dimensions should be increased to allow for shocks to which the rudder is subjected in stormy weather.

The shearing force on any pintle is the total pressure on the area supported by the corresponding arm. (See shaded portion, Fig. 4.) However, pintles when proportioned to the pressure acting on them will be amply strong to resist shear. The bearing pressure on pintles,

$$\frac{P}{D \times L},$$

where P is the total pressure acting on pintles in pounds and D and L are the diameter and length in inches, respectively, should not exceed 500 pounds per square inch where no lubrication other than water is furnished and about 800 pounds per square inch where lubricated.

The strength of the coupling joint must be equal to that of the stock. In a horizontal coupling the moment of the aggregate strength of the bolts about the rudder axis should be equal to the twisting moment of the stock.

Thickness of rudder plates range from ½ inch in small steamers to about 1¼ inches in liners. Where there is a possibility of backing into floating ice this thickness should be increased.

Various Formulae

If a ship is to be built to Lloyd's rules, rudder calculations are unnecessary, as detailed dimensions are given in their tables. In these the diameter of the stock is given for various speeds under numbers which represent the product of the total area of the rudder in square feet abaft the axis of the pintles and the distance in feet of the center of gravity of this area abaft the same axis.

Bureau Veritas' formula for diameter of rudder stocks for steamers of high speed is:

$$D = 0.18 \sqrt[3]{A B^2 V^2}$$

where

D = diameter in inches.
A = immersed depth of rudder in feet.
B = extreme breadth in feet.
V = speed in knots.

But in all cases the diameter must not be less than that given by their table.

The British Corporation formula is:

$$D = 0.26 \sqrt[3]{A r V^2},$$

where

D = diameter of stock in inches.
A = area of rudder in square feet.
r = distance from center of gravity to axis in feet.
V = speed in knots.

The German Lloyd's formula is (English measure):

$$D = 0.103 \sqrt[3]{A r V^2},$$

where r is taken in inches, other symbols being the same as for British Corporation.

Mackrow (1902) gave:

$$D = 0.392 \sqrt[3]{\frac{A U^2 d}{k}},$$

where

D = diameter of stock in inches.
A = immersed area of rudder.
U = speed in knots allowing 10 percent slip.
d = distance of center of effort from axis.

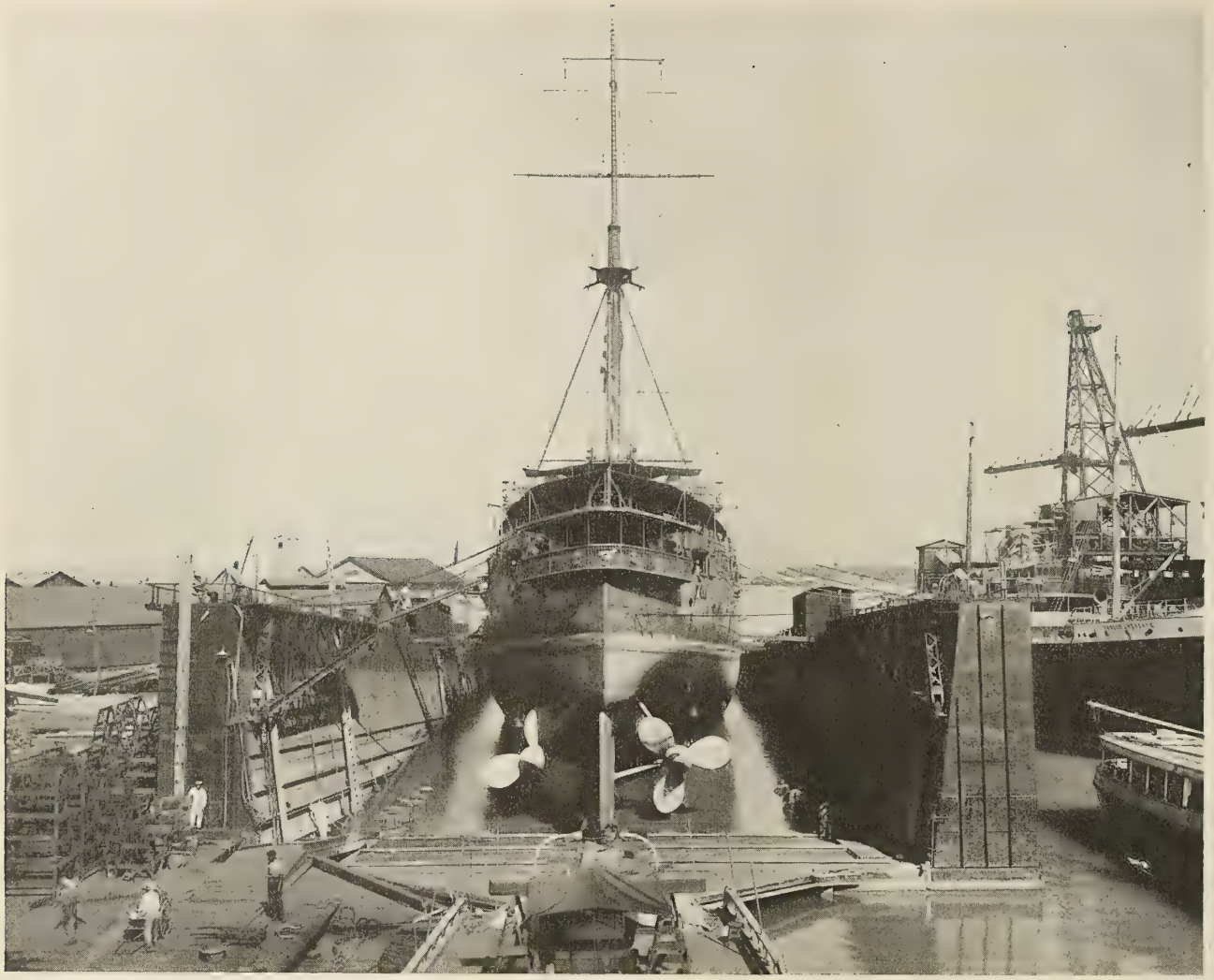


Fig. 1.—Stern View of Cruiser in Dry Dock

Extraordinary Feat of Dry Docking

Stern of 9,300-Ton Japanese Cruiser Raised Out of Water by 4,500-Ton Floating Dry Dock at Honolulu

ONE of the most remarkable feats ever known to have been accomplished with a floating dry dock was carried out recently by the Inter-Island Steam Navigation Company, Honolulu, with a floating dry dock of 4,500 tons lifting power designed and built under the supervision of William T. Donnelly, consulting engineer, New York.

The Japanese first class cruiser *Azuma,* which is a twin-screw vessel of 446 feet length overall and 430 feet length on the waterline, with a beam of 59 feet and a displacement on a draft of 25 feet of 9,300 tons, sustained damage to her propellers and it became necessary to get the propellers and shafting out of the water for repairs and replacement. The only dry dock available was the floating dry dock at Honolulu, which had a lifting power of only 4,500 tons and a length of 300 feet, as compared with 9,300 tons displacement and 446 feet length of the cruiser.

As it was impossible to place the entire vessel in dry dock, the dock was submerged and placed under the stern of the vessel, and then pumped out, with the result shown in Fig. 2, where it will be noted that one end of the dock is at its maximum submergence, while the other end of the dock has lifted the rudder and propellers of the vessel entirely out of the water. Fig. 1 shows a stern view of the vessel held in the dock with the propellers out of the water.

So far as known, this is the first time that such an extraordinary feat of dry docking with a floating dry dock has ever been undertaken, and its successful accomplishment is eloquent testimony to the enterprise and ingenuity of the engineers who carried it out, as well as of the utility of this type of dock for emergency work.

The Honolulu dry dock, which was used for this work, was described in detail in our issue for July, 1914. The dock has steel wings, 300 feet long, and eight wooden pontoons, making the length overall 352 feet. The dock has a width overall of 100 feet and a clear width between the wings of 80 feet. It is designed to take a draft of 20 feet over 4-foot keel blocks. The pumping machinery is operated by electricity and comprises eighteen 10-inch centrifugal pumps, one in each end of each pontoon. A 200 horsepower motor drives the groups of nine pumps on each side of the dock.

EXTRAORDINARY FEAT OF DRY DOCKING AT HONOLULU

Performed by Donnelly Floating Dry Dock of Inter-Island Steam Navigation Company

Fig. 2.—Floatation of Cruiser and Dry Dock with Vessel's Stern Lifted Out of Water for Repairs to Propellers

Shipbuilding Accidents*

(Concluded from July issue.)

Accidents from falling objects are of frequent occurrence in shipbuilding. Planks, bolts, hammers, wrenches, driftpins and various other tools and materials are often displaced or accidentally dropped by workmen, and the vibration resulting from the hammering and riveting also contributes to the general downfall, to the constant peril of workmen stationed below. Accidents of this nature can be greatly reduced by strapping or bolting the platform planks of the staging, as already recommended, and by providing all staging platforms and all shelves and other storage places with effective toe-boards or side-boards. Substantial overhead shields should be erected for the protection of all men who are stationed where they might be injured by the fall of objects from work-places at a higher level, and like protection should be erected over all passageways or gangways where a similar hazard exists. The spaces between the staging platforms and the hull of the ship should also be bridged over, as far as practicable, with wire mesh guards supported on pins thrust through holes in the bearer-bars of the staging, or in some other effective way. These can be made in sections, and used over and over.

The main gangways or runways, leading from the ground to the interior of the ship or to the staging platforms, should be well constructed and of ample proportions. They should be properly railed and provided with suitable landings at the top. Whenever there is any likelihood of material falling from them, they should also have toe-boards at both edges. A ramp or runway having a gradual rise, and provided with substantial hand rails on each side and with cleats to prevent slipping, increases the efficiency and the safety of the men. It seems hardly necessary to point out the importance of promptly removing ice and snow from all runways and platforms, and from all parts of the ship. Further protection should be provided by the liberal application of sand or ashes.

When the staging is dismantled, the various parts of it should be lowered to the ground by means of ropes, instead of being thrown down. If the material is thrown down there is always the chance of some one inadvertently getting in the way of a falling plank, or some one at a supposedly safe distance being hit by pieces that take unusual rebounds. With careful lowering, the timber is also far less likely to be broken or otherwise damaged.

Repair Yard Hazards

Some shipyards do overhauling and repairing, as well as new work, and although the hazards in yards of this kind are similar, in the main, to those that exist in yards that do construction work only there may be certain minor differences. A ship is not earning dividends while she is in the repair dock, and for that reason her owners usually insist that she be placed in commission again at the earliest date possible. This means that the repair men must plan in every way to save time, and a limitation of this kind often introduces new dangers. For example, painting the interior of the ship with standard oil-mixed paints necessitates considerable delay for drying, both between coats and after the finish has been applied, and in order to eliminate this delay it is customary to use quick-drying paints, containing highly inflammable substances, such as benzine, benzol or alcohol. Paints of this nature hasten the work, without doubt, but the use of them is attended by the risk of explosions and fires, and they may also produce injurious effects on the workmen. When paints containing volatile constituents that are inflammable or toxic are used in confined places, no open lights should be permitted, and smoking or the use of matches for any purpose whatever should never be allowed, on pain of immediate dismissal. The men should also have frequent periods of rest in the open air, and foremen should inspect all confined work places at least once every half hour while the work is going on. Good ventilation is highly important wherever paints such as we have described are being used, and if the quarters in which the men have to work cannot be ventilated easily and effectively by natural draft or by fans, a plentiful supply of fresh air should be introduced by means of a centrifugal pump and one or more lines of large canvas hose. The air should be delivered, in such cases, at the innermost part of the space, so that the objectionable vapors will be removed as thoroughly as possible. If the work is being done in a pit-like or well-like space, each workman should wear a belt with a stout life-line running up to the entrance to the work place, and *two* men should be stationed above, to draw the workmen up to safety in case they become overpowered, or show signs of drowsiness or of unnatural exhilaration. In some cases it will also be advisable to provide the workmen with special respirators, supplied with fresh air by a pump.

First-Aid Room

In view of the large number of minor injuries about a shipbuilding plant, it is highly important to provide a first-aid room, or a hospital. Bruises, slivers and cuts are not necessarily dangerous if they receive proper attention at once, but the average man will seldom quit work in order to attend to a slight injury, unless he can be treated immediately, so that he can return to his work without much delay. Even though he knows of hundreds of cases of blood poisoning due to the neglect of seemingly insignificant wounds, he will "take a chance" rather than go to his home or to the office of his family physician, for the treatment of a minor injury; but he can have no logical objection to receiving proper treatment by a competent person at the yard. The facilities at hand should be sufficient to render first-aid in the case of serious injuries also, because proper treatment of this kind has a large influence on the ultimate recovery of a badly injured man. It is important, however, to see that all first-aid work is done by a fully qualified person. Otherwise a great deal of harm may result.

In the shipbuilding industry there are a quite a number of cases of lead poisoning every year. The exposure is usually incurred while sandpapering painted surfaces or removing old lead waste (sometimes in confined spaces such as tanks, or between double bottoms or in bilges), or from breathing the fumes that are produced when red-hot rivets are placed in holes lined with red lead. Exhaust ventilating systems and a sparing use of lead paints tend to reduce this hazard.

Educational Safety Work

Educational safety work is specially important in the shipbuilding industry, which is admittedly a dangerous one. Moreover, the operations that must be performed are of such a nature that it is hard to provide mechanical safeguards that will afford a protection comparable with that which may be had in many other similarly hazardous employments. Here it is doubly important to study and promote safe methods of doing the work, and to instill the principle of personal caution into every employee about the yard. If the men can be brought to look at the safety question from the right point of view, and good "team work" can be secured, the accident rate will certainly fall off to a remarkable extent.

* From *The Travelers Standard.*

Company of Cadets on Camp Dewey Drill Ground

Young America Doing Its Bit

United States Junior Naval Reserve Training Hundreds of American Boys for Future Service at Sea

CAMP DEWEY, the big summer training camp of the United States Junior Naval Reserve, closed on September 1, after having been open from June 1, with an enrollment of over 600 cadets from all parts of the United States.

The United States Junior Naval Reserve was created to stimulate the interest of Americans in their navy and merchant marine by developing the sense of civic responsibility of the boys and young men of the country and then to fit them to fulfill any duty in life which may be imposed upon them. The method adopted provides for instruction and drills for boy cadets between the ages of 10 and 20; summer training camps for those between the ages of 14 and 20 and nautical schools and training ships for those young men who wish to enter the merchant marine as officers or adopt the sea as a career.

Camp Dewey is located in Uncasville, Conn., on the west bank of the Thames river, about five miles up from New London. It is ideally situated for a naval camp and a summer training school. On a high wooded plateau overlooking the river, with a splendid drill ground, a convenient dock and a new mess hall seating a thousand boys, the United States Junior Naval Reserve furnishes a summer camp that is splendidly adapted for the purpose of training boys of from 14 to 18 years of age for the navy or merchant marine.

There was not a boy who attended Camp Dewey for the weeks of summer training, but who returned tanned and rugged, fit and ready with head and hands, and with a new background of practical knowledge of land and water drill-work that will prove of value to him and to Uncle Sam in time of need.

The splendid work being done by the United States Junior Naval Reserve has received much commendation by statesmen, naval men and financiers who have visited the camps of the Reserve and have seen the results of the training in the well-drilled and capable cadets. Many prominent men interested in the extension of our navy and the creation of a greater merchant marine were at Camp Dewey during the summer, addressing the boys and reviewing the battalion during their stay by the Thames.

From their National Headquarters at 218 West Fifty-eighth street, New York, the Reserve is preparing now for the opening of their new winter base, Camp Josephus Daniels, at Palm Beach, Fla. At this camp work will be carried on up to May 15, when Camp Dewey will again be opened, and the banks of the Thames will again echo with bugle calls, young voices and marching feet.

Young America is doing its bit!

SWEDEN TO CONSERVE LIQUID FUEL SUPPLIES.—A royal decree has been issued in order to conserve Sweden's supply of liquid fuel and enforce economy in its use. According to this decree, permission must be secured from the Industrial Commission for the use of liquid fuel by motor boats or other vessels.

Camp Dewey Boys

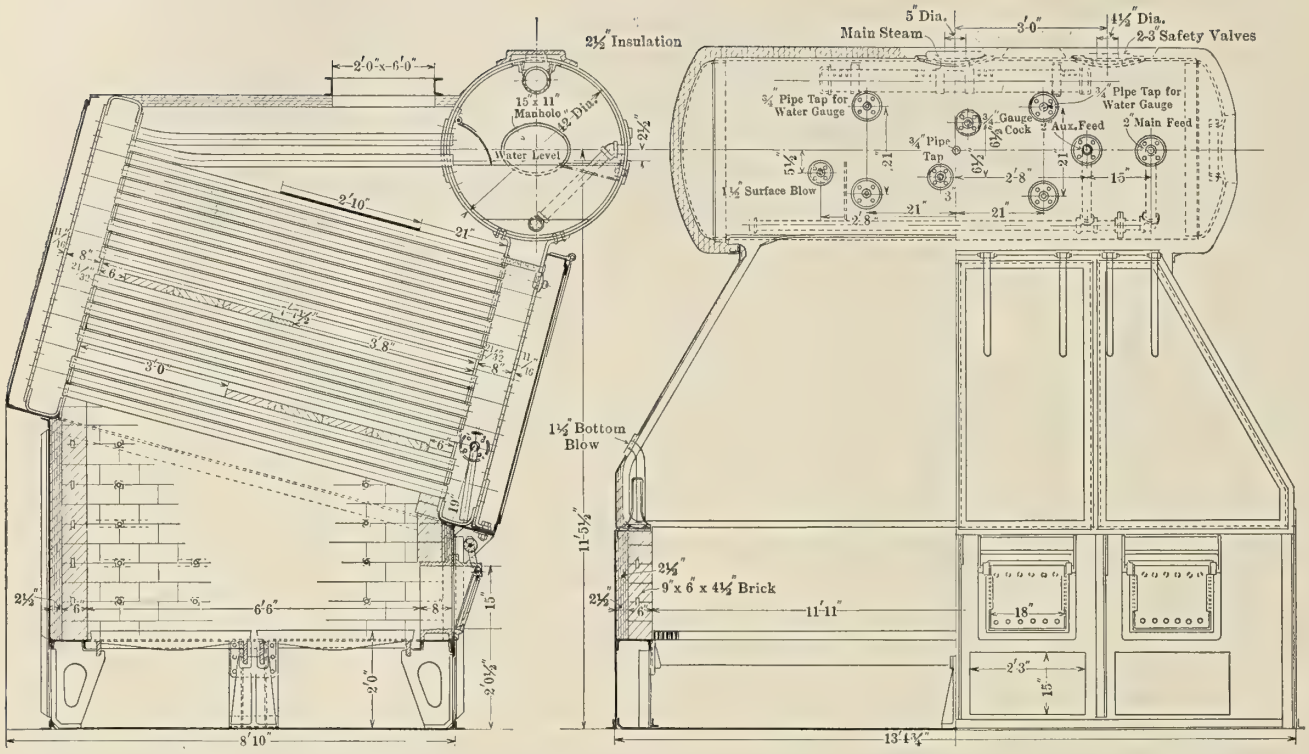


Fig. 1.—General Arrangement of Standard Boilers for Wooden Emergency Fleet

Standard Watertube Boilers for United States Emergency Wooden Steamships

Cross Drum, Straight Tube Type Watertube Boiler Designed by United States Shipping Board Emergency Fleet Corporation

Boilers for the standard wooden steamships of 3,500 tons deadweight carrying capacity which are being built for the United States emergency fleet will be of the marine watertube cross-drum type, with straight tubes expanded into continuous stayed steel plate headers.

The boiler has been designed by the United States Shipping Board Emergency Fleet Corporation, which has charge of the building of the ships for the Shipping Board, with a view of providing a simplified type of boiler composed of small parts which can be manufactured in large quantities with the utmost rapidity by practically any boiler shop in the country, wherever it may be located. The urgent need of getting the greatest possible number of cargo vessels into commission as quickly as possible to offset the destruction of merchant ships by German submarines, made imperative the adoption of a type of boiler that can be constructed by any boiler shop with its ordinary facilities and without the necessity of providing special machinery or equipment. It was necessary, also, that the boiler be of such type that it could readily be dismantled after construction and shipped from points inland to the seaboard.

As stated above, the boiler is of the cross-drum type with straight tubes expanded into continuous stayed steel plate headers. The height to the center of the steam drum is 11 feet 5½ inches; the width of the furnace front 13 feet 4¾ inches, and the depth from the furnace front to the back of casing 8 feet 10 inches. The grates are 6 feet 6 inches long by 11 feet 11 inches wide, giving a grate area of 77.45 square feet. The total heating surface is 2,544 square feet, making a ratio of heating surface to grate area of 33 to 1.

The heating surface is distributed as follows: tubes, 2,452 square feet; front header, 33 square feet; back header, 38 square feet; drum, 21 square feet. The tubes, of which there are 414 in all, are hot rolled, seamless steel, 3 inches outside diameter, of No. 11 B. W. G., except the three bottom rows, which are No. 10 B. W. G. All of the tubes are straight except the two top rows, which are bent to a 36-inch radius near the back header.

The steam drum is 42 inches inside diameter with bumped heads, one of which is solid, ⅝ inch thick, and the other 11/16 inch thick with a 11- by 15-inch manhole. The back header is stayed with 1¾-inch hollow staybolts and the front header with 1½-inch solid staybolts.

The boiler is designed for a working pressure of 200 pounds gage, and a hydrostatic pressure of 400 pounds

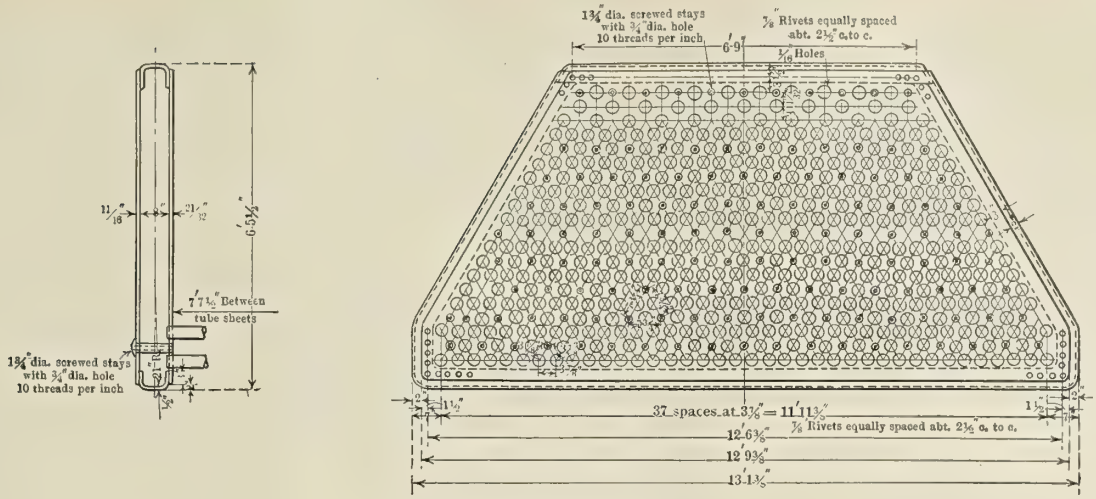


Fig. 2.—Back Header

gage. It will be fitted with a system of forced draft and is designed to evaporate 15,000 pounds of water per hour, with feed water at 200 degrees F. when burning about 20 pounds of anthracite coal per square foot of grate. The specifications embody the latest rules and regulations of the United States Steamboat Inspection Service applying to marine watertube boilers for ocean and coastwise trade, and the design has been approved by the Board of Supervising Inspectors and by the American Bureau of Shipping. No punching will be allowed on inside plates. All drilling and reaming for rivet holes shall be done from the outside after the plates are assembled. The use of drift pins will not be allowed. "Bulled" rivets are specified where possible, and they must be driven at a cherry red heat and held in the riveting machine at least thirty seconds.

The furnace is constructed of steel plates and angles designed to be readily dismantled for shipment. The firebox and casing part along a plane parallel to the inclination of the tubes and are so formed as to provide a support for the lower part of the front and back headers, as shown on the drawings.

The furnace is lined with special firebricks 9 by 6 by 4½ inches, having continuous grooves on one end to receive ⅝-inch square head bolts for fastening to the casing. These grooves are to be completely filled with high pressure cement and a thin coating of the same cement will be interposed between butts and successive layers of firebricks.

The ashpan is built up of steel plates made in sections for easy removal. The edges of the plates are flanged for bolting together.

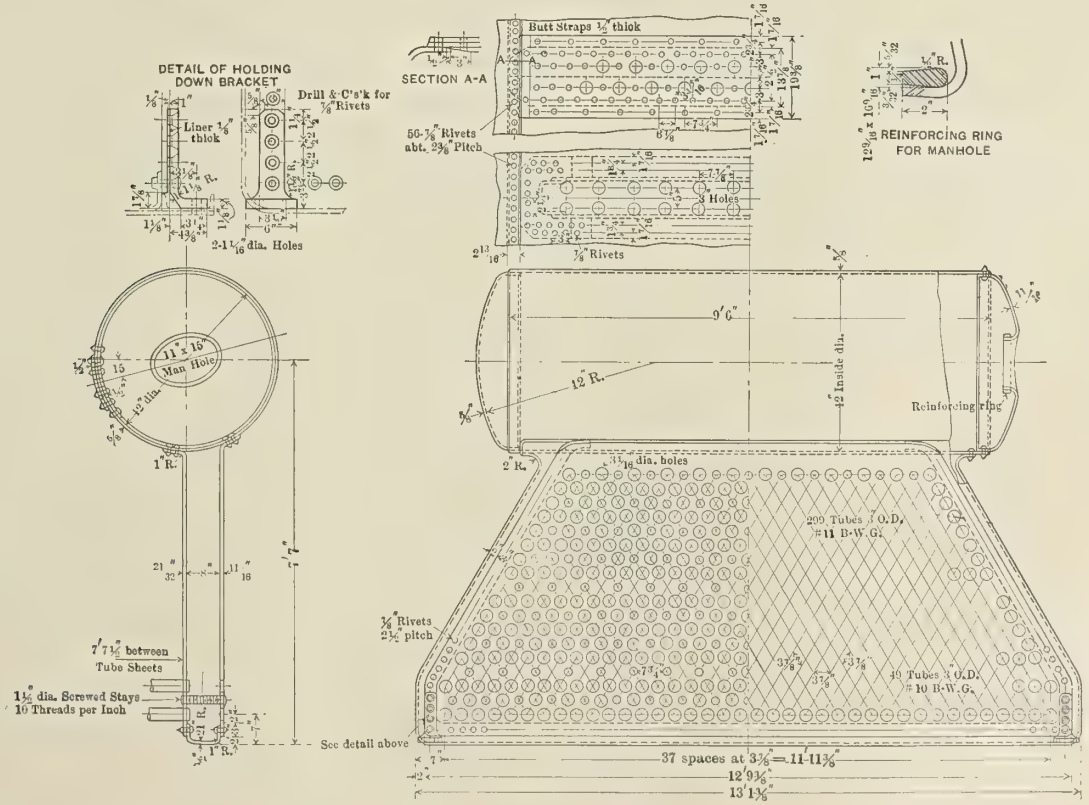


Fig. 3.—Drum and Front Header

Closing of Side Apertures From the Bridge*

Description of Device for Increasing Safety of Passenger Vessels by Simultaneous Closing of All Openings to Watertight Compartments

BY ING. E. BENVENUTI

ONE of the main principles formulated by the International Convention of London in regard to the design of ships was that the maximum length of each transverse watertight compartment must be proportional to the length of that portion of the hull having its center at the middle point of the compartment, which may be open to the sea without sinking the ship beyond a certain margin line. In this connection it should be remembered, however, that the ratio between the spacing of transverse watertight bulkheads and the floodable length has for many years been taken into account in the design of passenger steamers, particularly in the design of oceangoing liners, owned by large steamship companies. In this class of vessel it has been usual for the leading steamship companies to require, either from their own naval architect or from shipbuilders, that new ships should still retain a stipulated freeboard should one or more adjacent transverse watertight compartments become flooded.

It may also be added that the stipulations in regard to floatability and freeboard in damaged conditions, made by the steamship companies, for transoceanic passenger liners are, as a rule, much more rigorous than those fixed by the International Convention. For example, for a ship primarily engaged in carrying passengers and having a length at the load waterline equal to, say, 600 feet, the Conference Regulations state, under Article 8, that the maximum length of the transverse watertight compartments must not be more than 0.422 of the floodable length of the ship. That is to say, the ship, under the practical conditions of permeability of the various compartments assumed by the Convention, must be able to remain afloat when two of her compartments are open to the sea and the two compartments adjacent to these are filled with a quantity of water about four-tenths of their total capacity, taking into account their permeability.

In comparison with the above requirements it may be pointed out that there are already existing ships having the load waterline length referred to, which will be able to remain afloat with three transverse watertight compartments open to the sea, and there are under construction for the Navigazione Generale Italiana ships of this length which will be able to remain afloat with four transverse watertight compartments open to the sea. These ships, designed before the report of the International Convention was published, show that the leading steamship companies, fully realizing the moral responsibility undertaken by the owners of passenger ships, have not only freely adopted for several years past one of the main principles stated by the Convention, but have adopted that principle in a much more rigorous manner than was prescribed by the Convention.

The actual design and construction of the new vessels building for the Navigazione Generale Italiana, the dimensions of which will probably be those of many passenger ships in the near future, also demonstrate that it is possible for the naval architect to design a ship which will comply with all the requirements of the steamship companies in regard to passenger accommodation and suitability for a particular trade, and also present a degree of safety in damaged conditions far greater than that demanded by the International Convention. It is sufficient for this purpose to adopt a sufficiently high ratio between the molded depth to the bulkhead deck and the fully loaded draft, as the calculations in regard to transverse stability under different conditions of lading show that, with the usual values of the breath adopted in vessels of this type, there may be, corresponding to some initial conditions of the ship when undamaged, a sensible list at the beginning of the flooding, but that the ship will have sufficient transverse stability when the compartments are flooded to sea-level.

But it is most important to note that the above conclusions on the safety of ships in damaged condition depend largely upon the supposition that, whatever be the damage sustained by the hull, water cannot enter into any other watertight compartments than those aggregating the floodable length of the vessel corresponding to the damaged part of the hull. This is, for a passenger ship, a supposition which is capable of realization only under exceptional conditions, as hygienic necessities of comfort have turned the sides of every large modern liner into veritable sieves, owing to the hundreds of apertures made through the skin below the bulkhead deck.

Generally speaking, these apertures are of two kinds—overboard discharges and light and air apertures; but they all provide likely means of ingress for water to the inside of the ship in the event of an accidental increase beyond the load draft of the ship.

The first and most important effect of the flooding of any portion of the vessel is to increase the draft of the ship; either uniformly or with a change of trim depending upon the location of the damage. In either case an important fact arises in regard to the undamaged compartments of the ship, viz., the inner apertures of the overboard discharge pipes as well as the sidelights, which before the damage occurred were above the waterline, become in many cases submerged. The time required for such a sinkage, as well as the length of the portion of the hull for which the sidelights and the apertures of the discharge pipes become submerged, depend upon many circumstances differing for each special case.

Referring to the first point, experience has shown how, in many cases of extensive damage, particularly owing to the unavoidable list of the ship when flooding, only a few minutes elapse between the time of the damage and the submersion of the apertures. Referring to the second point, I think it interesting to give in Table A the results of calculations relating to the various trims of a ship having a watertight subdivision suitable for assuring her floatability with four adjacent transverse watertight compartments freely open to the sea in the case of a ship having the following principal dimensions:

	Feet	Inches
Length between perpendiculars	601	0
Breadth molded over frames	76	0
Molded depth to bulkhead deck	50	2
Load draft	28	0
Sheer at bulkhead deck forward	12	3

* Paper read at the Spring Meetings of the Fifty-eighth Sessions of the Institution of Naval Architects, London, March 28, 1917.

Sheer at bulkhead deck aft	4	10
Minimum height above L.W.L. of the sill of sidelights in the first 'tween deck	19	0
Ditto for the sidelights of the second 'tween-deck	10	6

The sidelights of the third 'tween deck being supposed to be kept permanently closed at sea have not been taken into account, and the vessel was supposed not to list over more than 10 degrees.

The results given refer to the various possible groups of four adjacent transverse compartments flooded, and they undoubtedly deserve the closest attention because they give an exact idea of the real conditions of safety of the ship in damaged condition. They clearly show how, in consequence of the flooding of a portion of the vessel, there are from *four* to *ten* undamaged watertight compartments, the sidelights of which become submerged, and these consequently may be, either entirely or partly, invaded by water passing through some open sidelights.

The calculations dealt with relate to a vessel of a special design with exceptional watertight subdivision, large sheer and a very considerable height above the line of the lowest row of sidelights which may be open to the sea, so that we must conclude that the real safety conditions of nearly all the vessels now afloat or building, should damage occur to their hull, will prove inferior to the case referred to. The above conditions would appear yet worse if we consider the possibility of some undamaged compartments being flooded through overboard discharge pipes, because the apertures of these pipes inside the vessel are not, as a rule, more than two or three feet above the deck. The striking results of the calculations lead, therefore, to the conclusion that in all probability if damage were sustained which opened to the sea a group of compartments not totaling the floodable length of the ship, this would cause her loss if all side apertures were not, at the moment of the damage, either already closed or immediately closed.

Both the International Conference, which met in London in November, 1913, and the Bulkhead Committee appointed by the Board of Trade, took into consideration the influence of the side apertures of a vessel upon her practical safety in damaged conditions. Article 23 of the Convention states that as a general rule all sidelights and overboard discharge openings must be fitted with suitable means for closing them, and must also be arranged in such a manner as to prevent, as far as possible, the accidental admission of water into the ship. With special reference to sidelights, Article 16 of the Regulations annexed to the Convention states the sidelights below a deck, the under side of which at its lowest point (at side) is less than 7 feet above waterline, must be kept permanently closed at sea. The article also forbids the fitting of sidelights in spaces exclusively devoted to the carriage of cargo or coal.

With reference to the overboard discharge apertures, the aforesaid article, besides requiring the largest possible grouping of the discharge pipes, also requires that discharges led through the skin from spaces below the margin line shall be fitted either with one valve that can be worked from a distance or with two valves, one of these being always accessible.

These requirements aim at increasing the limit of sinkage and inclination of the vessel at which water would eventually enter the undamaged compartments through open sidelights or discharge pipes, and also tend to increase the possibility of a closure of all sidelights and discharge openings, when the ship suddenly and greatly increases her draft by listing over or changing trim, thus making it difficult for the crew to reach the compartments below the weather deck.

In modern transatlantic liners the machinery, the bunkers, and the numerous passenger and deck services require a very large amount of space on board such ships, and consequently, in order to ensure a profitable working of the vessel, it is necessary to fit passenger accommodation also in the lowest 'tween decks. Fast liners having passenger and crew accommodation distributed in three 'tween decks below the upper deck are very usual, and will undoubtedly be more usual in the near future. Increasing demands for comfort will, moreover, necessitate in new passenger ships that sidelights of the lowest accommodation should be allowed to be kept open in fine weather at sea. That is to say, liners of the future will have three rows of open sidelights below the upper deck, which deck will also very often be the bulkhead deck, in order to avoid an excessive transverse subdivision of the hull. Further, the height of the lowest row of sidelights will often be small, corresponding to a height of the lowest point at the side of the second deck below the upper deck equal to 7 feet above the waterline.

Of course, in the above conditions, the immediate closure of the sidelights on the spot by hand will prove practically impossible, as many cabins are kept locked at sea, while other spaces on board are used as stores.

With regard to sidelights, we are consequently led to conclude that a modern passenger liner will in practice only realize the degree of safety at sea in damaged conditions for which she was designed, provided:

(*a*) Either all the sidelights fitted below the bulkhead deck are permanently closed at sea;

(*b*) Or a suitable and reliable arrangement for controlling all sidelights from the bridge or other central station is fitted on board.

If one of the above conditions is not fulfilled the degree of safety in damaged conditions of the ship, arrived at from her flooding calculations, will only have a theoretical value.

It is well known, however, that in the practical working of a passenger ship the first condition cannot be fulfilled, no matter what the climate is in which the vessel trades or the ventilating system installed on board. Passengers, and particularly cabin passengers, expect to be allowed to open the sidelights of their rooms, and very often refuse cabins having fixed sidelights or, at any rate, are only prepared to pay a low price for such rooms. It is therefore necessary to fulfil the second condition, and this would doubtless have been stipulated by the Convention or by the Bulkhead Committee had a suitable controlling arrangement been already devised at that time.

With reference to the overboard discharges, although these have a much smaller diameter than sidelights, and are fitted with storm valves, and are always connected to inside pipes of small diameter, the question of the reduction of their number as well as that of closing them in any emergency at sea is a very important one. A radical method for reducing to a minimum the number of the skin apertures is one, also given in the first report of the Bulkhead Committee, which consists in fitting in each watertight compartment, or in each group of watertight compartments, a drainage system having a collecting tank and suitable pumping arrangements. But the fitting of such an arrangement involves the addition of other mechanisms to the already numerous devices existing on board modern large passenger ships, and as it is not desirable to carry large pipes through the transverse watertight bulkheads, the arrangement proves very complicated and costly, and also requires two apertures in the skin of each of several compartments, because of the convenience of draining into separate collecting pipes and tanks, the

baths and washbasins, and the nests of water closets, even though use may be made of syphons on the separate discharges.

In my opinion, for nearly all passenger ships it is possible without having recourse to such a complicated plant, to make a sufficient reduction in the number of the overboard discharge openings by the following arrangement:

(*a*) Lead all water discharges from the deck below the bulkhead deck to the bilges of the corresponding watertight compartments;

(*b*) Group all the soil pipes from the nests of the water closets fitted in each watertight compartment into one overboard discharge;

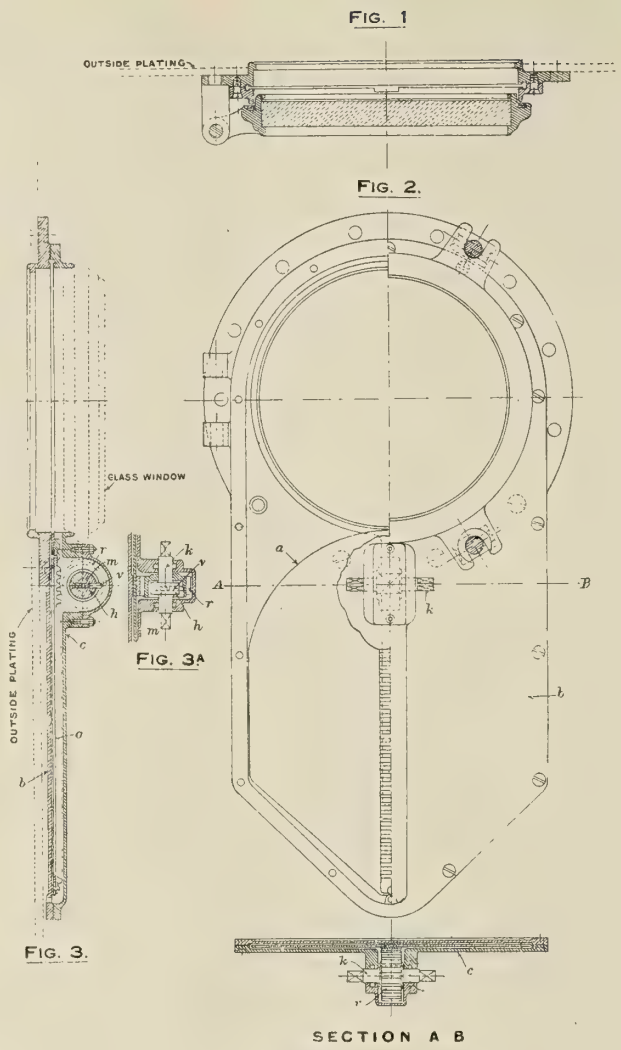
(*c*) Fit in each transverse watertight compartment two inclined collecting overboard discharge pipes in the 'tween deck immediately above the waterline, one on each side on the face of the reverse frames, into which all scuppers and water discharges must drain from the bulkhead deck and the decks above in way of the compartment. Into these collecting pipes the soil pipes of the private water closets may also discharge provided the number of the latter be not too great. Of course, in these collectors there must be a continuous circulation of salt water from the sanitary service.

With the arrangement just described the overboard discharge apertures will generally be reduced to two for each watertight compartment, and only in the compartments in which nests of water closets are fitted will there be three or, very seldom, four skin apertures required for discharges. By fitting to each aperture a skin sluice valve, the plant will prove as suitable and practical as that requiring special pumping arrangements, while certainly simpler and more economical in first cost and upkeep. With reference to the possibility of closing the overboard discharge openings in an emergency, it may be a matter for discussion whether the fitting to each aperture of a skin sluice valve worked from a deck above the bulkhead deck, in addition to the usual storm valve, represents the best device for the safe closing of these openings. But I must say, having designed such an arrangement for large liners now building, the result proved so complicated and costly in regard to the control rods and gears for the sluice valves that I do not recommend the installation of such a system. Another and greater disadvantage of such an arrangement is that in an emergency at sea a great deal of time and a number of persons will be required for the closing of all sluice valves owing to the unavoidable distribution of the control wheels throughout the full length of the ship, often in places not always easily and rapidly accessible to the crew.

Consequently we must conclude, as in the case of the sidelights, that it is necessary to have a suitable and reliable arrangement for the simultaneous closing from the bridge of all valves fitted on the overboard discharges, in order to ensure that the presence of the latter will not diminish the degree of safety in damaged conditions to the ship by her watertight subdivision.

The arrangement here described for the simultaneous closing from the bridge of all sidelights and overboard discharge apertures presupposes that the ship is fitted with the usual hydraulic plant for controlling the watertight doors from the bridge, as such a plant must now necessarily be provided in a modern liner owing to the requirements of the International Convention and the recommendations of the Bulkhead Committee in regard to the closing of the watertight doors. If such a plant is not available, a special small hydraulic plant would require to be added.

The principal features of the proposed arrangement are:



Figs. 1-3

(*a*) The fitting to each sidelight or skin aperture of a sliding shutter;

(*b*) The fitting, corresponding to each transverse watertight compartment, of a mechanism for closing the shutters, these mechanisms being identical in design for all compartments, but quite independent of one another in regard to their working.

The proposed type of sidelight is shown in Figs. 1, 2 and 3, and is fitted with a sliding shutter (*a*) made in gunmetal. The shutter, sliding in a vertical direction, closes the sidelight opening outside the glass, the closing being practically watertight, and it also protects the glass against breakage by objects floating near the ship. The illustrations show how the hinged part of the sidelight remains as usual and may also be fitted with a deadlight. The fixed part of the sidelight, however, is different from the usual practice and had an appendage (*b*), which forms a case for the shutter when the latter does not close the sidelight opening. The shutter is worked by a rack and pinion gear, the rack being riveted to the shutter, while the bearings of the axis of the pinion (*r*) are cast solid with the cover (*c*) of the case. The ratio between the diameter of the pinion and the stroke of the shutter is identical for all the sidelights in the ship, so that the closing of the latter requires an equal number of revolutions for all the pinions, actually about one and one-half or two revolutions.

The illustrations clearly show how the sliding of the shutter is quite independent of the opened or closed position of the hinged part of the sidelight. That is to say,

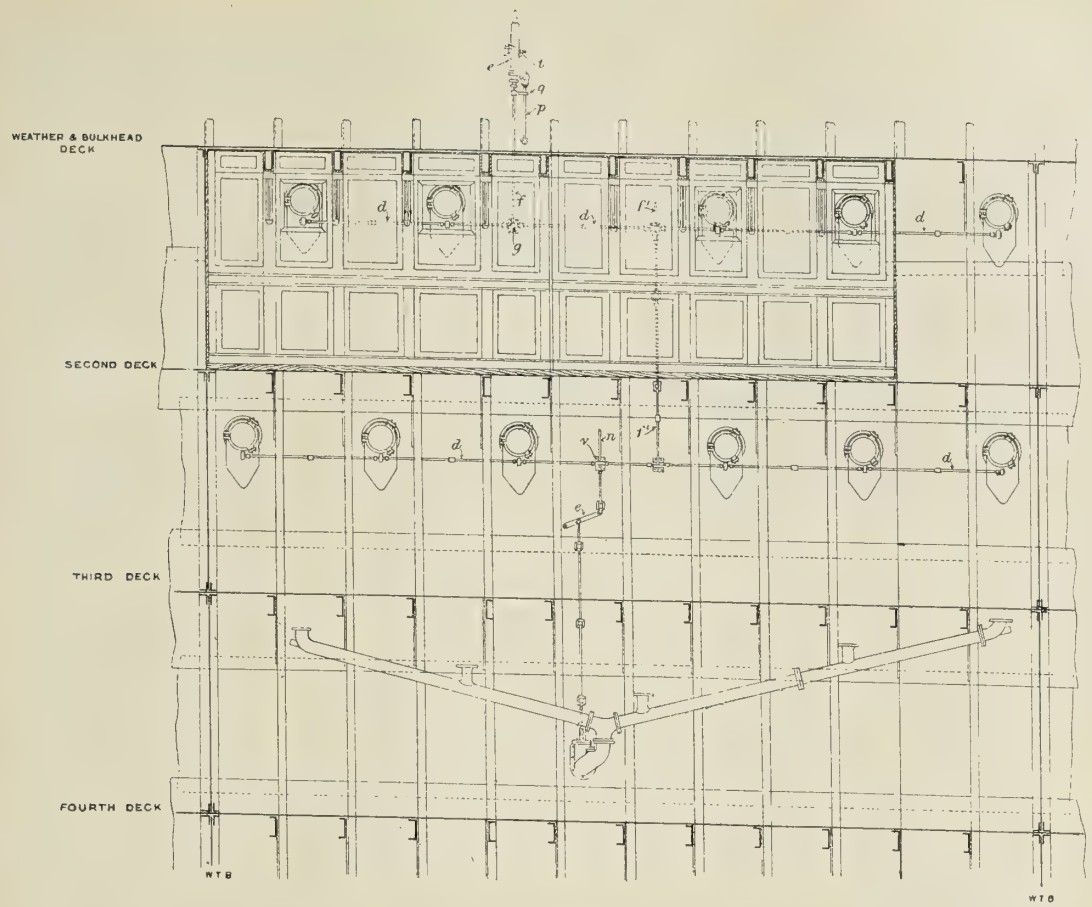


Fig. 4

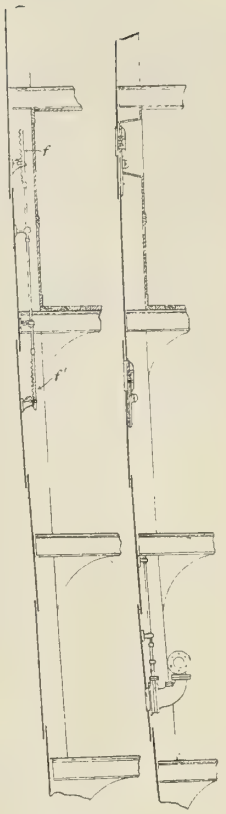


Fig. 5

the shutter only represents an additional closing arrangement for the sidelights, suitable for emergency use at sea, and leaves quite unaltered the usual working condition of the sidelight. The sidelights remain under the control of the passengers and crew, and it is immaterial whether, at the instant when the shutter must be closed, the glass window is open or not.

It must be noted that the proposed closing is only for emergencies; and although with careful workmanship the closing by the shutter may be made practically watertight, it must be remembered that absolute watertightness is not essential, as the proposed arrangement has for its aim, when damage to the skin occurs, to prevent, by a rapid control from the bridge, any appreciable quantity of water entering the undamaged compartments of the ship by passing through those of the sidelights which may be open at the instant of the damage and which may be situated in places not easily and rapidly approachable by the crew. As a rule, after closing the shutters from the bridge, the crew must then close by hand all glass windows and deadlights, but it is evident that the safety of the ship will not be compromised either because of time being required for that measure, or by the practical impossibility of closing some of the glass windows.

Figs. 4 and 5 show all shutters of the sidelights of one transverse watertight compartment fitted on each side of the ship may be closed simultaneously. It will be seen that the vertical spindles of the pinions working the shutters of the sidelights fitted on each side in each 'tween deck of a compartment are actuated by a horizontal shaft consisting of small horizontal rods *d* passing through the frames of the vessel. The various horizontal shafts are next connected up to a small vertical hydraulic cylinder *e* fitted against the plating, this cylinder being worked from the bridge by hydraulic power. The piston rod of each cylinder actuates a rack *f* engaging with a main pinion *g* keyed on the horizontal shaft controlling the shutter pinions of the upper 'tween deck. The two horizontal shaftings of the 'tween decks are connected by a system made of two racks *f'* and a rod between them, consequently when one shaft turns the other shaft turns also.

It will thus be readily understood that by turning a handle in the wheelhouse the pistons of the hydraulic cylinders fitted in each compartment actuate, through the racks *f* and *f'* and the main pinions *g*, the horizontal shafts for the various 'tween decks and thus close simultaneously all the sidelight shutters. By reversing from the bridge the pressure in the hydraulic system, the pistons of the small cylinders move in the opposite way and consequently open all the shutters.

To prevent failure of the system through an obstacle preventing the closing of one shutter, and in order to avoid serious injury to anyone who might have an arm or head through the light at the time of damage, each shutter is provided with a slip coupling by means of which the shutter will be thrown out of gear should the normal pressure in the hydraulic system not suffice to close it.

The details of the slip coupling referred to are shown in Figs. 3 and 3*a*. It will be seen that the portion *k* of the horizontal shaft which forms the spindle of each pinion passes freely across the latter. The spindle is provided with a collar *h*, which is arranged in a corresponding recess in the pinion. In the collar *h* is fitted a small pin *i* having a conical head which projects into a small groove cut into the rim of the pinion, through the action of a spiral spring *m*, thus ensuring that with a normal pressure the pinion will engage with the spindle and actuate the shutter. Should, however, the strain become too severe owing to any exceptional resistance preventing the sliding of the shutter, the head of the pin slides on the inclined

surface of the groove, thus forcing back the spring and disconnecting the pinion from the horizontal shaft, which remains free to turn and control all other shutters, leaving only the obstructed sidelight shutter open.

Fig. 4 also shows how easy it is with the arrangement now proposed to also close from the bridge the overboard discharge apertures. For this purpose a sluice valve must be fitted on each aperture between the usual storm valve, which sluice valve remains open at sea. For controlling the sluice valve from the bridge at the same time as the sidelight shutters, it is sufficient to fit a pinion *r* like that working each sidelight shutter on the horizontal shaft of the lowest 'tween deck, and a rack *n* engaging that pinion and controlling a lever arm *l* having its fulcrum attached to the ship's skin and directly working the valve rod. A slip coupling of the design already described, fitted between the pinion and the horizontal shaft, will leave the latter free to turn should an obstacle accidentally prevent the sluice valve closing.

The proposed arrangement is also suitable for immediately closing by hand, from the upper deck, each group of sidelights and overboard discharges fitted in the watertight compartment. For that purpose it is sufficient, as shown in Figs. 4 and 5, to fit near the piston rod of the cylinder a screwed rod *p* having fixed ends which may be turned by a handle, and also to fit on the piston rod a turning arc *q*, the free end of which may work as a female screw on the rod *p*.

By making the arm *q* engage with the screw *p* it is possible to work the piston rod by hand, and consequently also all the horizontal shafts connected to it.

The small cock *t*, cast solid with the cylinder, is so made as to allow, during the hand control, free communication between the two ends of the cylinder and simultaneously to cut out the connections of the latter with the hydraulic pipings. Such an arrangement of hand control fulfils in the best possible way the requirement of the International Convention that all valves on overboard discharges should be controlled from places situated on a deck higher than 7 feet above the low waterline, for with proposed arrangement all the valves fitted on each side of the ship within a watertight compartment would be controlled from a station above the bulkhead deck.

An experimental plant similar to the one now described was fitted in the last after watertight compartment of one of the large liners whose flooding calculations have been referred to in this paper: that plant includes twelve sidelights distributed in two 'tween decks and an overboard discharge valve. The working of the whole plant proved very satisfactory from all points of view, and the fitting of it in place did not present any difficulty.

The arrangement described for closing all the skin apertures is open to criticism, in that the sudden breaking of a cylinder or of the branch pipes to the latter, from a collision or explosion, would cause the pressure to fall throughout the hydraulic system and thus prevent the control from the bridge, not only of the skin apertures, but of the watertight doors. For this reason it may be advisable to have separate main piping for the control of the doors or a small automatic valve could be fitted at each point where a pipe to a cylinder branches from the main piping, these valves being so arranged as to shut off the flow of water from the main piping should the pressure in any of the branches suddenly fall.

It is evident that the proposed arrangement fully solves the problem of the immediate simultaneous closing from the bridge of all ship side openings in any emergency at sea, but in order to judge of the advisability of installing the system in a modern passenger ship we must also consider the questions of reliability, first cost and upkeep.

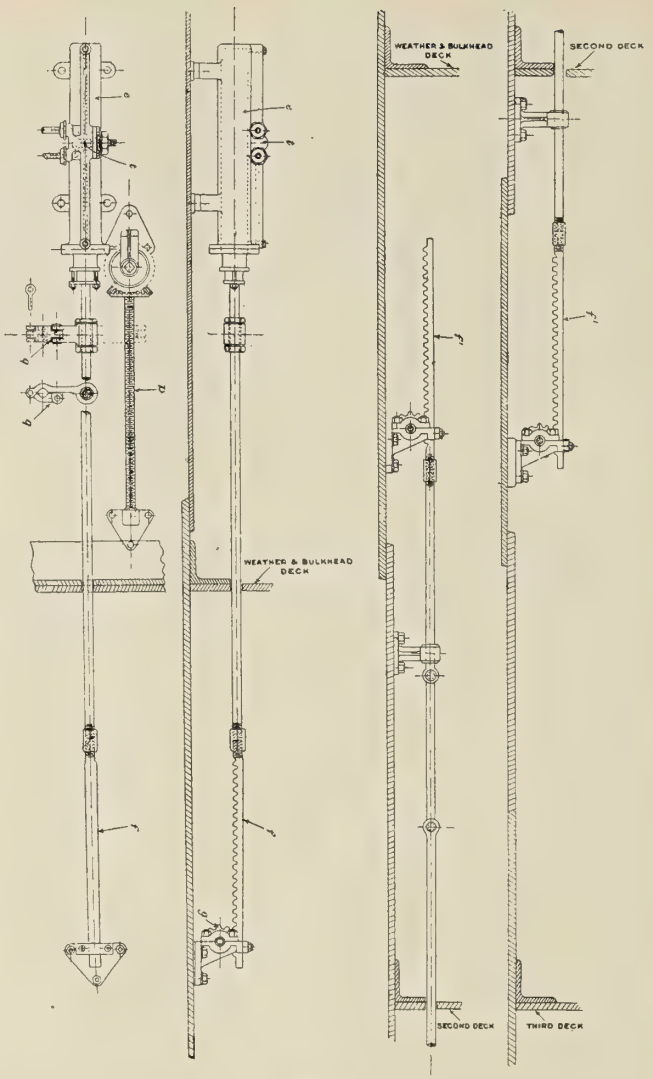


Fig. 6

With reference to reliability, it should be noted that even for a large liner the proposed arrangement entails nothing more than the fitting in each transverse watertight compartment of two very simple installations, one on each side, these installations being identical with each other and with the installations for all the other compartments of the ship. Each installation works independently from all the others, although they are all connected to the same main piping. As will be seen from Fig. 6, the various parts are plain and simple in design and are efficiently and strongly connected together. The moving parts are few and their movements are small and simple and not subject to shocks or reversals of load. The motive power, hydraulic, is the most reliable we can desire. Provided the upkeep of the packings of the small pistons and of the rod stuffing boxes be regularly attended to, no part of the whole plant should fail to work well. Another advantage of the arrangement is that the parts can be easily protected from interference by passengers. In fact, the sidelight shutters remain concealed in a metallic box, and the sluice valves also remain hidden in their boxes. Both the hydraulic cylinders and the controlling gears are fitted near the plating, within the depth of the frames, and are thus concealed by the inside lining in cabins, while in compartments having bare plating the whole plant may be readily protected by wood lining fitted over the frame space where the cylinder and the racks are

placed, and by a batten fitted in front of each horizontal shaft.

With reference to the question of initial cost, it is, of course, evident that the proposed arrangement will prove more costly than the usual arrangement of plain sidelights and overboard discharges, the increase in cost depending more or less upon the care bestowed upon the workmanship and the quality of materials used. I may say that estimates made by first-class firms for first-class plants to be fitted on board passenger ships having about four hundred sidelights and skin valves to be controlled from the bridge show that the extra cost does not reach 1½ percent of the total cost of the vessel: that is not a big figure to pay for the greatly increased safety of the vessel in damaged conditions—that is, for the possibility of converting the hull of the vessel, in any emergency at sea, into a hull without any aperture in the undamaged compartments, and thus fulfilling in fact the fundamental hypothesis on which the calculations referring to her floatability in damaged conditions are based.

With reference to the upkeep of the plant, this entails only the overhauling of the piston and rod stuffing box packings. Owing to the very small movement of the different parts, lubrication is not needed, especially if, as is advisable, pinions, racks, pinion bearings and rod guides are made of bronze or are bronze lined. Neither the sidelights nor any other part of the plant require any special survey or upkeep other than the usual inspection and cleaning periodically required by every plant on board a vessel when laying in harbor. If the precaution is taken to fit loose sheathing in contact with the moving parts, the periodical overhauling and cleaning will not present any difficulty.

U. S. Coast Guard Puts in Commission New Type of Self-bailing, Self-righting Motor Lifeboats

Motor lifeboats of a new type, self-bailing and self-righting, have recently been built by the Camden Anchor-Rockland Machine Company, at Camden, Maine, for the United States Coast Guard. Two of these boats were launched in July, and two more are now under construction, which will probably be launched in October. The first two boats have just been delivered at the Coast Guard Station, New York, having made the run to New York from Camden under their own power.

The boats are 36 feet long over all and 8 feet 8 inches beam. The power plant consists of a 40-horsepower model "F" Sterling motor, fitted with electricity and hand starters. The motor is installed in the after end box, which is a watertight compartment.

Fig. 1.—Self-Righting Test of Motor Lifeboat

Fig. 2.—Latest Type of Coast Guard Motor Lifeboat Fully Rigged for Service

Lifeboats similar to these have been used by the United States Coast Guard for many years and are well known along the coast. The old style boats were fitted with centerboards, while in the new type of boat this centerboard is omitted, and the necessary changes are made in the design and construction to do away with the centerboard. The cockpit deck is above the waterline. It is watertight and is fitted with ten self-bailing copper tubes, tin lined. All the available space under the cockpit deck and all available space under the side seats in the cockpit, as well as the space under the floor in the forward end box, is filled with air cases made of clear white pine covered with canvas laid in glue and painted several coats.

The boats are so designed that when placed bottom up they will right themselves and at the same time bail themselves out. The builders were obliged by their contract to put one of the boats through such a test, which was successfully accomplished. The boat righted herself in three seconds and bailed herself out in fourteen seconds.

The material used in the construction of these boats is the very best to be had. The planking throughout is Port Orford cedar, the frames clear white oak, the fastenings copper and composition, and the general interior construction mahogany. The boats are planked diagonally, two courses of planking being used. Before applying the second course the first course is covered with canvas in one piece, laid in glue, which, considering its weight, is the most rigid construction obtainable.

These boats are fitted with two masts and three sails, and arranged to take eight oars. They will easily accommodate fifty persons, if the occasion ever requires it. Under power the boats show a speed of a little better than eight knots, which, considering the size of the power plant and the heavy construction, is remarkably good.

They are designed for patroling the coast and are assigned at the different Coast Guard stations.

Traffic Through the Panama Canal.—According to figures published in a recent issue of the *Canal Record*, containing a summary of traffic through the Panama Canal since its opening in August, 1914, until the close of business on July 30, 1917, the total number of vessels passing through the canal in this time was 3,751 and the cargo tons 15,339,093. The highest total occurred during the fiscal year 1917 when 1,876 vessels passed through the canal, the cargo measurement being 7,229,255 tons.

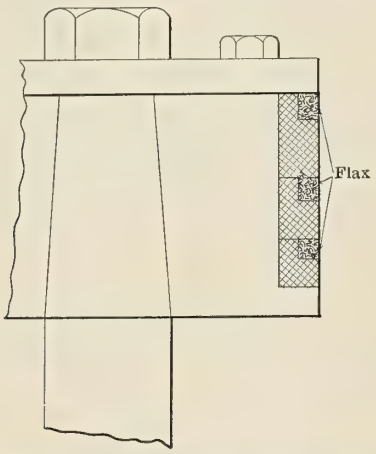
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Combination Packing

The sketch shows how a set of combined flax and white metal packing was made for the plunger of one of our bilge pumps. We found that there was no 5/8-inch flax or hemp packing on board ship, and non-available at the port



Combined Flax and White Metal Packing

we were in. Having plenty of Babbit metal, and 3/8-inch flax, we decided to make the combination.

The working results were very good. Babbit metal alone soon gives trouble, due to the wear of coal and ash grit drawn up from the bilges. This combination packing proved to give long service; and, in fact, is still doing duty.

Concord, N. H. C. H. Willey.

Curiously Deflected Furnace

A peculiar case of deflected furnace crowns came to the writer's attention recently. A steamer was being brought around from the Great Lakes to an Atlantic port. This vessel was fitted with a jet condenser, having been built for use in fresh water only, and it was decided by her new owners that she could be brought around without installing a surface condenser, although she did not have any fresh water tanks.

Engineers from the Atlantic Coast, accustomed to navigating in salt water, were sent to bring the vessel around. Soon after leaving Montreal trouble developed with the boilers. The tubes and staybolts in the back combustion chamber of the starboard boiler leaked so badly that the fires would hardly burn. The port boiler furnished enough steam to keep going, although at very slow speed.

The culmination of the trouble came when both furnaces in the port boiler bagged. The engineers immediately hauled the fires and worked the pressure off, leaving the vessel helpless. A boat was sent ashore and a tug sent out to tow her in.

The furnaces were of the Adamson ring type, in three sections each, and were bagged in three places in the back section over the bridge-wall, to a depth of 12 inches. There were two bags in the center section of about the same depth, while there was only one bag in the front section about 3 inches deep.

Usually when this type of furnace becomes overheated they come down in one bag between the rings, and it is rather difficult to understand why these furnaces bagged as they did. There was one-half inch of scale over the entire furnaces, except where it had broken off where they came down, and the entire section should have heated evenly, although it is evident it did not.

The back ends of all the tubes were burned so badly that they had to be renewed, and about 350 staybolts in the back connections were found pulled through the sheets. The chief engineer was given a suspension of license for six months, which gave him time to learn something about the use of a jet condenser in salt water.

J. S.

A Pointer

A high vacuum is essential to economy, and to that end we must keep the vacuum or air pump in efficient condition. If the valve disks of the bucket plunger and valve decks are not tight, the efficiency of the pump is then impaired. As these valves are invariably made up of three thin circular bronze disks, they are very flexible, and when they become coated with heavy grease (and most all of them do) they soon collect grit and chips between themselves and their seats. This holds one edge

Fig.1

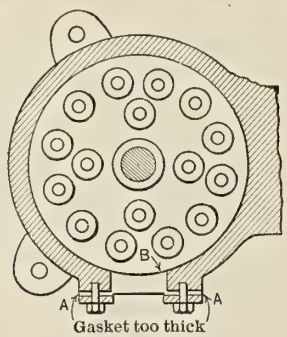


Fig.2

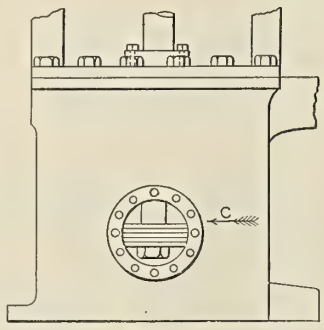


Fig.3

Fitting Handhole Plate to Barrel of Air Pump

of the valve off the seat and allows back leakage of a portion of the air and water. If a number of these valves get in this condition the vacuum drops and it becomes necessary to speed up the number of strokes per minute of the pump to maintain a fair vacuum. At the first chance the valves should be cleaned of this foreign matter.

To make the cleaning and inspection of the valves easy, as it has to be done often, most all air pumps have a hand-

hole plate fitted into the barrel of the pump, as shown in Fig. 3, at *C*. The shape of the inside surface of this manhole is that of the inside diameter of the cylinder. The manhole is fitted in place at the time of manufacture of the pump and bored at the same time as the cylinder, so that the inside of the plate is a part of the cylinder wall surface. This plate is then marked with suitable figures and marks, in order that it will always be fitted in its place correctly—something in the manner shown in Fig. 1. Care should be taken that these marks are not painted over.

Fig. 2 at *A* shows a pointer to watch out for in placing this plate back on after the cleaning or inspection is finished. A gasket of just the correct thickness, which is generally a thin piece of brown paper soaked in linseed oil, must be used; for if a too thick gasket is used it will leave a clearance between the surface of the plate and the edge of the plunger—as shown at *B*, Fig. 2. Each time the plunger passes this part of the cylinder there will be a back leakage, due to this opening, and if more than one plate is fitted to the cylinder it seriously affects the condition of the pump. An easy way to make sure that the plate is in correct place is to place the pump plunger in position, as shown in Fig. 3 at *C*, and lay a piece of thin, soft lead wire over the edge of the plunger and then put the plate on and secure tight. Remove it again and note the thickness of the lead. If O. K. replace and secure.

C. H. Willey.

Concord, N. H.

Piston Area Chart

To subtract the area of the piston rod has always been a sort of "pest" for engineers in general when making computations for horsepower directly from indicator diagrams. The head end of the cylinder has always been easy enough to work out, but the crank end invariably contains that infernal piston rod.

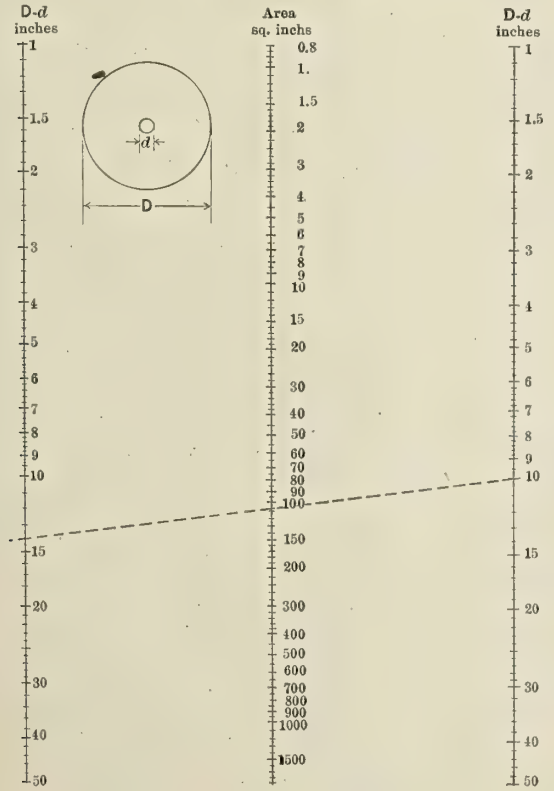


Chart No. 1, Giving Piston Area

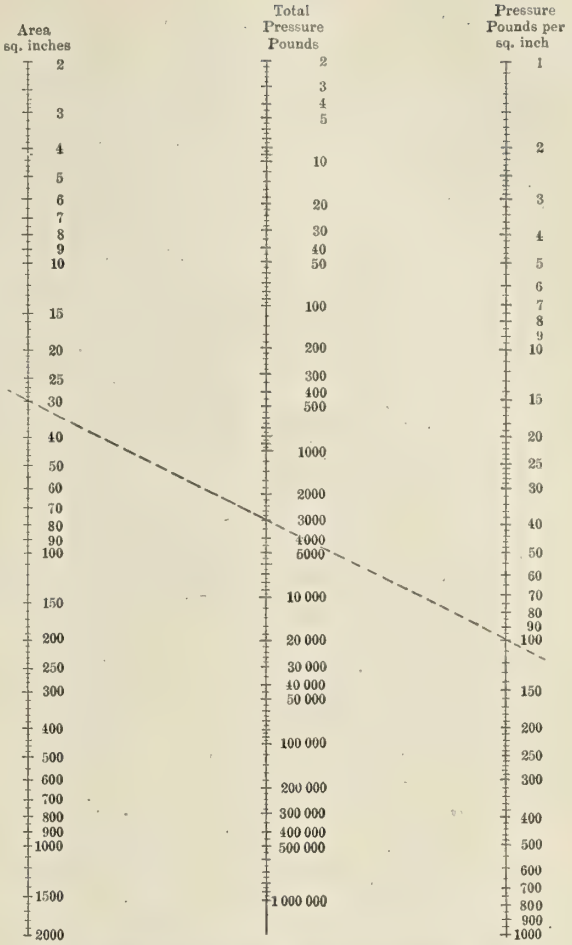


Chart No. 2, Giving "Area × Pressure"

The other day I hit on a scheme for lightening the labors of making computation of this sort, and prepared Chart No. 1 for that purpose. I believe the idea is "brand new" and it works as follows:

Where D = diameter of cylinder in inches,
and d = diameter of piston rod in inches,

just add D and d and find the corresponding figure in the left-hand column of the chart. Then subtract d from D and find the corresponding figure in the right-hand column. Connect the two figures with a straight line and the middle column gives the area with the piston rod area already subtracted.

If the chart isn't accurate enough for you it will at least tell you whether or not your long-hand figures are "anywhere near accurate."

For example, I have chosen a 12-inch cylinder and a 2-inch rod. My figures, therefore, are 14 and 10, and the middle column shows the area to be very close to 108 square inches. Computed the long-hand way, I find the area to be actually 108.2 square inches. So the chart is fairly close.

The chart can also be used just as readily for finding the area of the head end of the piston. In that case d = 0, and we have to use D in each column.

For example: Find the area of a 10-inch circle. Just connect 10 in the left-hand column with 10 in the right-hand column, and the intersection will come close to 78. Mentally, perhaps, you can figure that the exact area of a 10-inch circle is 78.54 square inches. It happens to be exactly equal to 25 π.

"Area × Pressure" Chart

After finding the area of the piston we always have to multiply by the "mean effective pressure." To lighten

that task, or at least to make you sure of your figures and decimal points, Chart No. 2 was designed.

The chart is very simple and needs no further explanation. The dotted line drawn across shows that 30 × 100 = 3,000. The range of the chart is wide enough for almost any steam pump or hydraulic problem inside of 1,000 pounds per square inch. N. G. NEAR.

New York.

Finding "Faults" in Electric Wiring

Breakdowns of the insulation of cables, leading to faults later on, may often be avoided by periodical tests of the insulation of the cables, followed by an examination of those in which the insulation shows signs of deterioration. The insulation test is a very simple one; it is shown diagrammatically in Fig. 1. An instrument made for the

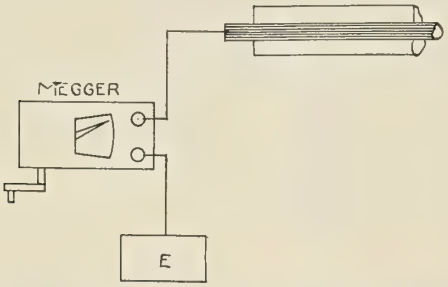


Fig. 1.—Diagram Showing How the Insulation Test Upon Insulated Cables is Carried Out by Means of the "Megger"

One terminal of the megger is connected to "earth," the frame of the ship and the outside of the cable; the armor or the lead covering also makes more or less good connection with the frame of the ship, so that the megger measures the leakage current through the insulating envelope of the cable, and from that the insulation resistance has been calculated, the dial of the instrument being arranged to read that quantity direct

purpose, and called by various names; one sold in the United Kingdom is called "megger," because it measures the insulation resistance in megohms. The megohm is a million ohms, and well-insulated cable always has an insulation resistance of several hundred megohms per mile before it is fixed. The tests can easily be carried out in harbor; but in doing so each length of cable should be taken separately, the conductor at one end being connected to the "megger," and at the other end left free in air, as shown in the figure. Insulation tests of the whole distribution system may also be taken with advantage at sea, but the result of those tests will be a very much lower resistance than that of any single cable, because of the leakage which takes place at every fitting.

Usually the first warning of a "short," unless careful tests have been made periodically, on the lines indicated above, is the blowing of a fuse, and then the trouble begins. The blowing of a fuse is not always a certain indication of a "short," because fuses themselves are unreliable after they have been in service a certain time. Like everything else, fuses have been enormously improved during the last twenty years; but even the best fuses are liable to deterioration. The metals of which the fuses are composed oxidize, and though this process goes on very slowly it has the effect of gradually lessening the sectional area of the fuse, increasing its electrical resistance, thereby increasing the heat liberated by any current passing through it, and lessening its mechanical strength. In addition, fuses on board ship are exposed to a number of stresses due to the vibration of the engine, the working of the ship in a heavy seaway, and so on, and these tend to loosen it.

A very useful appliance for testing for "shorts," when they are suspected, is an incandescent lamp of the pressure of the service, fitted with a pair of connections, as shown

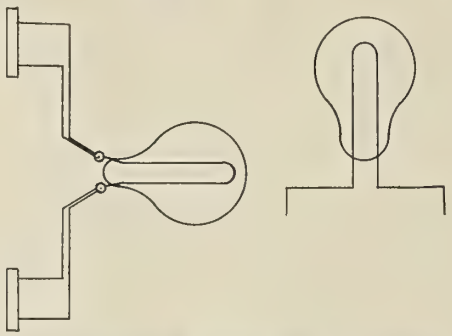


Fig. 2.—Diagram Showing How an Incandescent Lamp Can Be Arranged with Plate Terminals to Slip Between Fuse Locks

in Fig. 2, so that the connections can be pushed between the clips of a pair of fuse contacts. If there is a "short" on, the lamp will light up; if the fuse blew because it had deteriorated, the lamp would not light, and this may be confirmed by placing another fuse in position.

Shorts are somtimes intermittent, especially on flexible cords; the two conductors may get together temporarily, blow a fuse and then fall apart. Intermittent faults are the most troublesome of all; they can only be watched for. If the lamp lights up it is a sure indication that the "short" is in whatever wires are controlled by that fuse, and if the fuse is either on the main switchboard or a main distribution board, the matter may be followed by removing the fuses of the next board, then replacing the fuse in the board nearer to the dynamo, then inserting the lamp in place of each fuse in succession. This course may be followed, from distribution board to distribution board, until the pair of cables or wires, or the single cable or wire where the single-wire system is used, is denoted.

"Shorts" occur in all sorts of places on board ship; sometimes on main feeders, sometimes on sub-feeders, and sometimes on the smaller wires. If the fault is on a main feeder it will be shown by the lamp lighting when placed in the fuse blocks of all the sub-feeders; and similarly if the fault is in a sub-feeder, it will be indicated by the lamp lighting up when it is placed in all the fuse blocks of the branch wires.

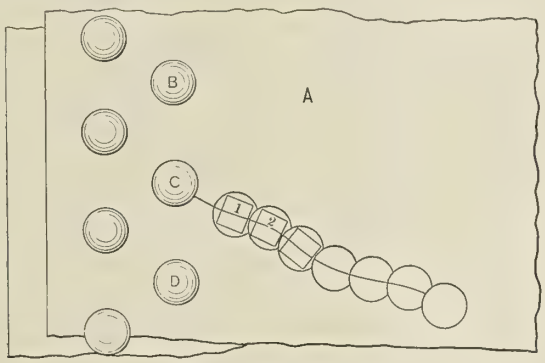
It will be understood that the lamp is so valuable for this test because it saves the wasting of fuses and it gives a very clear indication of where the trouble is, and it can be safely used because its resistance is sufficient to reduce the current flowing through the "short" to the figure the lamp can stand. One trouble with heavy "shorts," connections between large main feeders, or cables carrying large currents temporarily, always is the difficulty of handling the large currents. As long as the "short" is on, immediately a connection is made in the ordinary way, a heavy current flows and a considerable amount of heat is liberated in the conductor and in everything connected with it. When an incandescent lamp is inserted in the circuit only the current that lamp can accommodate flows, because the fuse blocks where the lamp is inserted now take the place of the lamp holder, and the pressure at the fuse blocks is the same as would exist at the terminals of the lamp holder under ordinary working conditions. The lamp also may sometimes perform another useful service; it may indicate a partial short circuit by causing the lamp filament to glow at a lower temperature.

Emergency Repair of Crack in Boiler Shell

When this war broke out, I wanted to do my "bit," and, being twenty-eight years old and a boiler maker by trade, I went down to the navy yard and told them I wanted to enlist. They looked at my teeth, weighed me and punched me and asked me questions, and then I was accepted. I was sent aboard a ship a day or two after.

I am not a sailor, but I had been on a good many trial trips of ships and never was seasick, so I enjoyed the life for the first ten days, only I didn't have much to do. There was a sort of a boss boiler maker and another fellow named Cary on board. Everything went so smoothly I thought I wasn't going to get much experience, but at the end of the first ten days I saw something done which was new to me, so I thought it might interest your readers.

I am not much at making sketches, but here is one which will perhaps help out my description.



Plugging the Crack

The ship was fitted with four shell boilers which were quite new. One afternoon No. 3 boiler seemed to be leaking at the front end and Cary and I were ordered to go up on the boiler to see what the trouble was. When we got up under the deck beams it was so hot we could hardly see, but we ripped off the covering of the boiler and found a crack running from one of the rivets of the tube sheet down towards the longitudinal seam for a distance of about five inches.

The crack wasn't leaking badly, but spitting water and steam all the time. When we got down we reported and the chief engineer was sent for. When he had taken a look at the crack he was pretty red in the face and looked mighty sober. He ordered the boiler cut out and told the firemen to let the fire die down; then he went up on deck to talk with the captain. When he came down he said we would have to put a patch on the leak and wanted to know how long it would take us.

The foreman boiler maker looked it over and said it would take sixteen hours, as a man could not work up there on the boiler top for any length of time on account of the heat. But the captain wouldn't listen to this; he had to get somewhere and he had to have that boiler. Cary suddenly stepped up to the chief and said: "I have only been in the navy a short time and I may be getting in all wrong with you, but if you want that leak stopped I can do it inside of two hours if you will give me the men." The chief asked how he could do it, and Cary, taking a piece of paper and pencil, made a sketch and described his idea. After thinking the matter over a moment, the chief turned to the boss boiler maker and said: "See that this man gets all the help he wants. His suggestion will answer, but we will have to watch that leak carefully."

Carey got the carpenter down and got him to make a kind of backing up under the deck beams for the electric drill. Then he sent me up to the machine shop to have them make seven pipe plugs out of bar steel. A young officer went up with me and gave orders that the plugs were to be rushed right through. The head machinist was a clever fellow. He put a piece of bar steel through the head of the lathe, held it in the chuck, tapered the plug, then ran the die over it, cut it off long enough to leave the squares, screwed it into the T-fitting and shaped off the squares in a little shaper they had.

I went into the boiler room and by this time the steam had run down so that there was no pressure on the boiler. Cary and I got up on top of the boiler and he drilled the first hole through the boiler shell as shown on sketch and marked No. 1. This he tapped. Of course the electric drill was used, its head backing up against the rig that the carpenter had rigged up.

We had to wait a few minutes for the first plug, but it gave us time to cool off and get a rest. Then we screwed in the first plug, bringing the square so that when we drilled the second hole, for plug No. 2, it wasn't in the way of the drill which, it will be noticed, cut into plug No. 1 as well as into the shell of the boiler. Here is just the whole trick; if the plugs didn't cut into each other, there would be a steam leak between them.

We went down the crack to its end and a little beyond, as shown in the sketch, taking several rests, but we got the last plug in one hour and twenty-five minutes after we started, although we were both played out with the hard work and the heat.

The chief took a look at it and ordered steam got on the boiler. Then it was connected up with the rest of the battery and the plugs failed to show a bit of a leak anywhere.

We got an extra five days' leave when we came to port, but there has been no end of discussion on the ship as to whether the plugs weakened the boiler or strengthened it. They put a patch on while Cary and I were ashore. If I get nothing else out of my Government job, I think I have learned a clever trick, and so I am passing it along to others.

New York. A. Float.

BOOK REVIEW

American Bureau of Shipping, Great Lakes Department, 1917. Size, 12 by 8 inches. New York, 1917: American Bureau of Shipping. Price, $25.

Since the reorganization of the American Bureau of Shipping, the publication formerly known as the *Great Lakes Register* is now published as the Great Lakes Department of the American Bureau of Shipping. The *Register* contains complete lists of steam and sailing vessels on the Great Lakes, giving main particulars of both the hull and machinery, as well as the names of the builders, owners, date of construction, etc. At the end of the book are given a list of American owners and managers and also a list of Canadian owners and managers. The book is completed by miscellaneous tables of data, giving sailing distances on the Great Lakes, a list of the dry docks, floating docks and marine railways, as well as a list of the lake vessels whose names have been changed and shipbuilders on the Great Lakes.

The book is conveniently arranged and indexed so that it can be used for ready reference. The data regarding the steam and sailing vessels are tabulated in sequences and blank spaces are provided for the insertion of additional items. Supplements are issued during the year.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

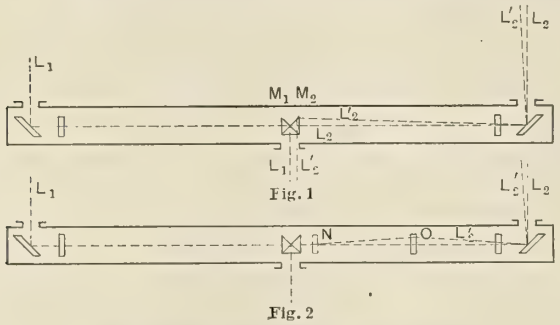
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Range Finding

Q. (894).—Please recommend a book explaining how ranges are found for directing the fire on board ship at sea.

A. (894).—There is an excellent chapter on the general subject of range finding at sea in the following text-book: "Ordnance and Gunnery," a text-book for the use of midshipmen at the U. S. Naval Academy, published by the U. S. Naval Institute, 1910, and in the 1915 edition entitled "Naval Ordnance" (same publishers, cost $4.85). The latest type of the Barr & Stroud range finder is described in detail and instruction given as to its use and care (Chapter XXI). The following statement of the basic principles is abstracted from this.

Barr & Stroud Range-Finder.—The Barr & Stroud range-finder belongs to the short-base, single-observer class, and is constructed to work on the "coincidence" principle. Figs. 1 and 2 are diagrammatic representations



Diagrammatic Sketches of Range Finder

of the instrument, details of construction being omitted for the sake of clearness in the explanation of the principle of operation.

The principle of the instrument depends upon the diverging angle at which the rays of light come from the target to the reflectors. Fig. 1 is a diagrammatic representation of the elements of the range-finder reduced to their simplest form. Two beams of light from the distant object are received by the reflectors and transmitted through the objectives towards the center of the instrument, where two small mirrors, M_1, M_2, are placed, one over the other, to reflect the rays outward through the right eyepiece. In this way, two partial images of the distant object are seen, one over the other; the image seen in the upper half of the field of view being formed by the equivalent of a telescope directed towards the distant object from the *right* end of the instrument, and the image seen in the lower half being formed by the equivalent of a second telescope directed towards the distant object from the *left* end. The images are separated by a thin, black line called the separating line.

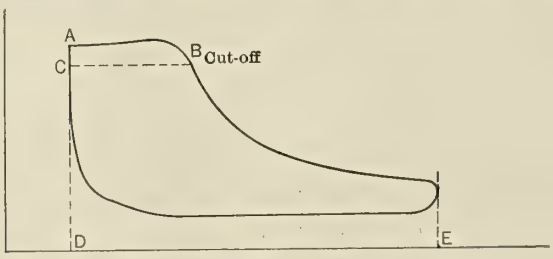
If the object approaches the instrument in the direction of the beam L_1, the beam L_2 will have a new direction, such as is indicated by the line L_2', and the partial images will no longer be seen in the eyepiece in proper coincidence. Accordingly, means are provided (1) for altering the path of one of the beams as it approaches the central mirrors, so as to bring the partial images into correct alinement or coincidence, and (2) for indicating on a scale the distance that is moved in sympathy with the motion of the mechanism which produces the alinement of the images. The alinement of the partial images is effected by causing one of the beams (in its course from the objective to the central reflectors) to pass through a deflecting prism of small angle, which is movable in the direction of the length of the tube, and is moved into the required position by the operation of a working head situated on the outside of the tube. The action of the prism is illustrated in Fig. 2.

The scale, which consists of a straight piece of translucent ivory, is seen through the left eye-piece, and is caused to move past a fixed pointer which indicates the range of the object whose images have been alined in the right eye-field of the instrument. The observer need not move his eyes away from the eyepieces to keep a moving object in view and read its distance as often as he desires.

Cut-Off on Indicator Card

Q. (901).—How do you figure the cut-off from an indicator card?

A. (901).—The point of cut-off is usually located where the admission and expansion lines interesect, *i. e.*, where



Indicator Card Showing Point of Cut-Off

the diagram changes its curvature from convex to concave. The cut-off percentage is the ratio of $C\ B$ to $D\ E$.

Defects in Cast Steel Valve Bodies

Q. (906).—In inspecting cast steel valve bodies, what are the commonest defects met with? Should a porous casting be rejected, or is it possible for the manufacturer to make it tight?

A. (906).—Steel castings commonly possess any or all of the following defects: porosity, blow-holes, sand pits, blisters and cracks, each of which may be remedied if not of too serious a nature. Porosity, if slight and local, may be corrected by peening, but if extended the casting should be replaced.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Ljungstrom Steam Turbine

Q. (907).—What is the Ljungström steam turbine, and is it an important type or is it a modification of the Parsons or Curtis types?

A. (907).—The Ljungström steam turbine is a radial flow reaction turbine, with blades carried on two concentric disks rotating in opposite directions. The steam enters from the shaft, flows radially, expanding to the exhaust, located in the rim. It operates at high speed and is capable of using very high pressures and superheat, all of which tend to give it a low steam consumption. Its reported economy is probably the best of any commercial turbine. It usually drives direct two A. C. electric generators, which are kept in step electrically and thus maintain the proper relationship of the turbine disks. It has been applied to ship propulsion with excellent results and has been seriously considered for submarines. The parent company is the Swedish Ljungström Steam Turbine Company, Ltd., of Friespong, Sweden, but one of the large American electrical firms is the American licensee.

Mean Effective Pressure Referred to Low Pressure Cylinder of Triple Expansion Engine

Q. (908).—What should be the mean effective pressure referred to the low pressure cylinder of a modern three-cylinder, triple expansion engine taking steam at 190 pounds gage and with a vacuum of 27 inches?

A. (908).—For best economy, about 45 pounds per square inch.

Reinforced Concrete Ships

Q. (909).—Are there any successful reinforced concrete seagoing ships?

A. (909).—No. Reinforced concrete has been used with varying degrees of success for barges, pontoons and vessels for inland waterway navigation up to 150 feet in length and even greater, but there has been no case of a successful seagoing self-propelled vessel of reasonable size. There has been much attention directed toward it of late, however, and it is probable that its field will considerably broaden for small craft.

Tests for Gasoline (Petrol) Engine Cylinders

Q. (910).—Is there any pressure test required for gasoline (petrol) engine cylinders.

A. (910).—Lloyd's rules for internal combustion engines require that : "The cylinders are to be tested by hydraulic pressure to twice the working pressure to which they will be subjected. The water jackets of the cylinders to 50 pounds per square inch, and the exhaust pipes and silencer to 100 pounds per square inch."

Ratio of Gear Reduction on U. S. S. Neptune

Q. (911).—Will you please tell me the amount of the gear reduction which is used on the U. S. S. *Neptune?* If you can refer me to a descriptive article on this installation, I should much appreciate it.

A. (911).—The ratio of propeller shaft to the turbine shaft is 1 to 9.04. For an excellent description see "Notes on the Performance of the Reduction Gear and of the Bridge Control System of the U. S. S. *Neptune*," which was published in the *Journal of the American Society of Naval Engineers,* August, 1912. Vol XXIV, No. 3, Page 987 *et seq.*

Sperry Searchlight

Q. (913).—What is the candlepower of the new Sperry searchlight which is being used in this country and England? Can you give me a brief description of its principal features?

A. (913).—The following from *Aviation,* April 15, 1917, gives the most recent published information:

"It illuminates a target ten times as brilliantly as an ordinary projector, and its arc is as bright as sunlight.

"The brilliancy of this lamp is due, among other things, to the special carbons. The arc burns at a temperature of 10,000 degrees F. The candlepower of the 60-inch Sperry searchlight exceeds 1,250,000,000.

"An important feature of this searchlight is the remote control, which is very desirable for anti-aircraft work. By means of this apparatus the lamp can be operated, even upward at an angle of 90 degrees, from a distance as great as one mile. This lamp can be used for other purposes, such as coast defense work, for which its long range makes it specially suited. The 60-inch Sperry searchlight has been seen 150 miles away. The lamp can also be used for signaling and is installed on naval vessels.

"The installation of these new searchlights, together with the use of incendiary bullets for machine guns, is said to have resulted in the stopping of Zeppelin raids on London. Searchlights stationed at coast towns pick up the Zeppelins and permit the heavier than air machines to destroy them."

Torsional Vibration in Shafting

Q. (912).—What is the principal factor in causing torsional vibration in line and propeller shafting?

A. (912).—Briefly, irregularities in turning moment which synchronized with the torsional period of the shafting and propeller. This is most frequently due to faulty apportionment of work among the cylinders.

Engler Scale of Viscosity of Oil

Q. (914).—Will you please explain to me what is meant when the viscosity of an oil is quoted as so many degrees Engler?

A. (914).—Degrees Engler means simply the ratio of the time it takes a given quantity of an oil to flow through a standard orifice as compared to the time it would take the same volume of water to flow through.

Metacenter

Q. (915).—Will you be willing to give me some sort of a description of what the metacenter is? Some description that is in words, not figures. I think if I can once get clearly into my mind some definite conception of it, I will be much helped in my understanding of the many problems in naval architecture which deal with it. As it is, I have read the definitions in several text-books, but do not get a very clear idea, perhaps because of my lack of facility in reading mathematics.

A. (915).—I think it will help you to read the following quotation upon metacenter from Rear Admiral D. W. Taylor's (Chief Constructor, U. S. N.) paper, presented before the Franklin Institute recently:

"In mathematical language, the metacenter is the center of curvature of the locus of the center of buoyancy of the vessel as it is inclined. As a practical proposition the metacenter is the limit above which we cannot locate the center of gravity of the ship without having it initially unstable and unable to remain upright. The position in space of this imaginary point depends upon the geometrical form and the dimensions of the ship. Perhaps a homely illustration may clarify the matter. If you take an ordinary rocking chair and attach a weight to it in such a manner that the center of gravity of the chair and the weight is above the center of curvature of the rocker, the chair will not stay put, but will roll and capsize. If the center of gravity is materially below the center of curvature of the rocker, which is the case when one sits in an ordinary rocking chair, the chair will remain in a fixed position; if the rocker is very flat, resulting in a greater distance of the center of gravity below the center of curvature, the chair will be stiff and harder to rock or heel from the upright position. The metacenter of a ship corresponds very closely with the center of curvature of the rocker, as already described.

"The metacentric conception applies only to initial stability with the vessel upright."

MODERN MARINE TERMINAL AT BEAUMONT, TEXAS

Designed by H. McL. Harding, Consulting Engineer, New York

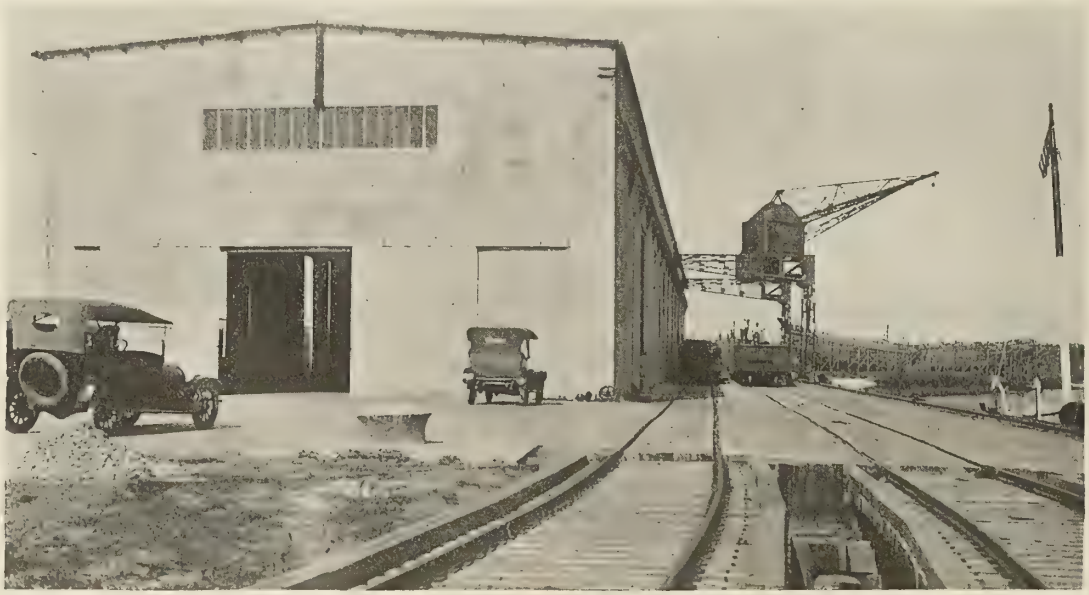


Fig. 1.—West End of Quay and Shed Showing Half-Arch Gantry Cranes Serving Shed, Railroad Tracks and Drayway

Fig. 2.—Half-Arch, Traveling, Gantry Jib Cranes; Capacity at 200 Feet Per Minute, 2 Tons; Traveling Speed; 300 Feet Per Minute; Revolving Speed, 3 Revolutions Per Minute

Fig. 3.—Surface Crane Rail 2 Feet from Edge of Quay Wall. Elevated Rail Attached to Shed Wall. Clear Height of Under Side of Gantry, 24 Feet; Height of Crane Hook Above Rail, 50 Feet

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

AMERICAN MERCHANT MARINE TO TOTAL OVER 13,000,000 TONS OF SHIPPING

Nearly 3,000,000 Tons Now Engaged in Foreign Trade

United States Will Have 1,600 Merchant Ships, Aggregating 9,200,000 Tons, by End of 1918

The United States has to-day 458 ships of over 1,500 tons deadweight each with an aggregate tonnage of 2,871,359, either engaged in or capable of participating in foreign trade, according to figures just published by the Shipping Board.

There are also 117 ships of 700,285 tons of German or Austrian origin. Further, the Emergency Fleet Corporation has commandeered nearly 400 steel ships of more than 2,500,000 tons, which are being completed or under contract for construction in American yards. The Fleet Corporation has also contracted for 636 ships of 3,124,700 tons.

Totaled, these figures show that the United States will have near the end of 1918 a merchant fleet of more than 1,600 ships aggregating 9,200,000 tons to carry its foreign commerce, as compared with an overseas fleet of 1,614,222 tons on June 30, 1914, scarcely a month before the European War began.

The tonnage referred to is exclusive of that engaged on inland waters, unsuitable coastwise craft operating along the coast and in bays and harbors, and does not, of course, include the prospective additional programme of the Emergency Fleet Corporation.

The fleet in prospect is already becoming a reality. Several of the commandeered ships are already taking cargoes; others will leave the ways in increasing numbers with each succeeding month. The ships for which the Shipping Board has contracted are under construction and the first launching is expected within sixty to ninety days.

American Ships Requisitioned

The Shipping Board announces that every American merchant vessel of more than 2,500 tons deadweight carrying capacity available for ocean service will be requisitioned by the Government on October 15. The total tonnage available for this purpose is slightly over 2,000,000.

The rates at which these vessels will be chartered by the Government involve a sharp reduction in present charter rates.

Welding Ring Appointed Chairman of Ship Chartering Board

Welding Ring, a shipping man of New York, has accepted the position of chairman of the projected chartering board which will operate under the Emergency Fleet Corporation. Two other shipping experts will serve with him on the chartering board.

The new chartering board will have authority to approve and grant all charters for all American vessels. In this way it is expected that the Shipping Board will have absolute jurisdiction over all American shipping, and will enforce a schedule of freight rates for transportation of war shipments. The chartering board will sit in New York.

The new board will co-operate with Allied shipping control agencies to effect virtually a domination of the world's tonnage.

Atlantic Deeper Waterways Meeting

The tenth annual meeting of the Atlantic Deeper Waterways Association will be held in Miami, Fla., from November 27 to December 1. An interesting programme of business sessions and entertainments is being arranged, and an opportunity will be given the visiting delegates to see the waterway improvements under way in Miami and vicinity, where the city is constructing a public dock 1,000 feet long, with a public terminal railroad, and a commodious channel and causeway is being built by Dade County. An access to these improvements is being provided by the Government channel and jetties connecting with the ocean.

Shipbuilding Contracts

It is reported that the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from the Navy Department, Washington, D. C., to build about thirty destroyers, to cost in the neighborhood of $37,000,000. This company has under contract a total of twenty-one destroyers and two scout cruisers.

Oscar Daniels & Company, Brunswick, Ga., are reported to have received a contract from the United States Shipping Board to build several steel vessels at a plant to be erected at Brunswick.

It is reported that more than 125 vessels are under contract in the shipyards of the State of Oregon.

The Cushman & McKown Shipbuilding Company, Wilmington, N. C., is building a 1,500-ton freight steamship.

Wright & Cobb, Rockland, Me., are building a 300-foot freight steamship for the Great Northern Paper Company.

The Housatonic Shipbuilding Company, Bridgeport, Conn., has received a contract to build ten wooden ships.

CONTRACTS FOR GOVERNMENT SHIPYARDS SIGNED

Three Yards to Be Built for Construction of Fabricated Steel Ships

Vessels of 5,000, 7,500 and 9,000 Tons to Be Built

Contracts for the construction of a Government-owned fabricated steel shipbuilding plant on Hog Island, near Philadelphia, Pa., were signed by officials of the United States Shipping Board Emergency Fleet Corporation with the American International Corporation on September 13. This contract calls for the construction of fifty fabricated steel vessels of 7,500 tons deadweight carrying capacity, although provision is made for increasing the number to 200 when the necessary funds are appropriated by Congress.

More recently contracts have been signed with the Submarine Boat Corporation, of New York, for the construction of a similar plant on Newark Bay for the building of fifty standardized fabricated steel cargo ships of 5,000 tons deadweight carrying capacity each, and with the Merchants Shipbuilding Corporation, of Chester, Pa., for the construction of 9,000-ton cargo ships of fabricated steel. The contract with the Submarine Boat Corporation calls for deliveries to begin in June, 1918, and for the entire fifty vessels to be completed by December 31, 1918. This contract will involve the expenditure of approximately $40,000,000.

The building programme, it was announced to Congress, will cost in all about $400,000,000. It has been reported that the Government will bear the expense for the construction of the three shipyards, and that $35,000,000 will be required for this purpose. The contract with the American International Corporation for fifty 7,500-ton ships will total $55,000,000 as a basic price. The actual cost, however, will vary according to the fluctuations in the cost of material, labor and other items of expense.

Never before have shipbuilding contracts of this magnitude been entered into in the United States. It is understood that contracts for the fabricated material required by the American International Corporation and the Submarine Boat Corporation will be sublet by the contractors through a joint commission appointed by the two companies, so that no disastrous competition or congestion will cause any serious delays in getting out the work. Details of the designs of the ships have so far been withheld.

It is believed that ten or twelve months will be required for building the first 7,500-ton ship.

New Shipyards Planned and Under Construction

The plant of Grant-Smith-Guthrie-McDougall Company, Portland, Ore., is nearly completed. This company is reported to have contracts to build fourteen steel ships.

The Schaw-Batcher Company has bought 172 acres of land at Redwood City, Cal., where it will build a shipyard. The company is reported to have received a contract to build eight steel steamers.

The Pacific Steamship Company, San Francisco, Cal., has purchased a shipyard site at Brandon, Ore., where it will build wooden schooners.

The Naul Shipbuilding Company has been incorporated at Wilmington, N. C., by A. P. S. Naul, George Rountree and Thomas W. Davis. A 6-acre site has been secured for a wooden shipyard.

The American Shipbuilding Company, Richmond, Va., is said to be planning the construction of a steel fabricating works for ship construction. The headquarters of the company are at 11 Broadway, New York. S. H. Brown is president.

The Union Timber Products Company, Seattle, Wash., will build a wooden shipyard at Port Townsend, Wash.

The Hall Steamship Company has been incorporated for the purpose of building a shipyard. Madison C. Hall, C. N. Riker and S. W. Harrington, all of Washington, D. C., are the incorporators.

Heldenfels Bros., Beeville, Tex., are planning to build a shipyard near Rockport. They are reported to have received a contract from the Government to build four wooden hulls.

The Hampton Roads Shipbuilding & Dry Dock Company, Norfolk, Va., has been incorporated, and is reported to have secured a site at West Norfolk. Gaylord W. Feaga is president; J. D. Carey, vice-president, and J. T. Sweeney, secretary and treasurer. The present headquarters are at the offices of the Gaylord W. Feaga Company, Citizens' building, Cleveland, Ohio.

The Erickson Engineering Company, Seattle, Wash., has been organized by C. J. Erickson, Downs Block, Seattle, and others. It is the purpose of the company to build ships at a yard on the Duwamish River.

The Concrete Fabricating Company has been incorporated to build steel and concrete barges and boats. W. S. Sawyer, J. T. Brady and C. F. Daly, 308 West Fifteenth street, New York, are the incorporators.

The Foundation Company, 233 Broadway, New York, will build shipbuilding plants at Portland, Ore., and at Vancouver, Wash., in addition to other locations already announced.

Arthur W. Brittain, 65 Cedar street, New York, and others, have incorporated the Continental Shipbuilding Company.

The Manistee Shipbuilding Company, Manistee, Mich., will begin operations about October 1.

The Merchant Marine Construction Company has been incorporated, with offices at 308 Haas building, Los Angeles, Cal. The company has secured a site of 10 acres at Long Beach, and will invite bids on steel ships. P. Livingston Barnes is the general manager.

The California Shipbuilding Company, Long Beach, Cal., is planning extensive enlargements to its plant, and is reported to have received a contract from the Government to build three steel freight ships.

The Valk & Murdoch Company, Charleston, S. C., has prepared plans for the construction of a 440-foot floating drydock.

The Cape Fear Shipyards Company has been incorporated, with headquarters at Wilmington, N. C., by New York parties.

The Los Angeles Standard Wood Steamship Company has been incorporated, with headquarters in Los Angeles, Cal.

W. A. Boole, Martinez, Cal., has leased 30 acres of waterfront for a shipbuilding site.

It is announced that the Nicholl Terminal Company, Richmond, Cal., will build a shipyard for the construction of both wooden and steel ships.

The Pacific Coast Shipbuilding Company, Oakland, Cal., has been incorporated, with a capital stock of $5,000,000.

Benjamin F. Graham, San Diego, Cal., has secured 6 acres of land, on which he is planning to build a shipyard.

The U. S. Steel Corporation, through Ward B. Purley, vice-president and general manager of the Canadian Steel Corporation, Toronto, Ont., announces that the company will proceed with its projected $20,000,000 development work at Ojibway, Ont. The company is advertising for bids for the construction at Ojibway of a slip and huge concrete and steel docks.

Largest Wooden Passenger and Freight Ship Ever Built in South is Launched

The wooden steamer *Maple,* the largest passenger and freight-carrying ship ever built in the South, was launched with appropriate ceremonies at 4 o'clock on the afternoon of September 15 at the yards of the Slidell Shipbuilding Company, Slidell, La. Miss Sallye Hart Hailey christened the ship.

The *Maple* will be ready for service in about forty-five days. She is 190 feet long, 34 feet beam, with a cargo depth amidships of 11 feet 6 inches and outside depth of 13 feet 4 inches. Her beam over all is 38.8 feet. She has stateroom accommodations for twenty passengers. She will be placed in passenger service between Miami and Jacksonville, Fla., by the Coast Steamship Company, of which Charles L. Dimon, of Mt. Vernon, N. Y., is president.

Southern pine is used almost exclusively in the ship, which is designed for a speed of 10 knots. She will be propelled by an 800-horsepower engine.

The *Maple* was the third wooden steamship to be launched at the Slidell yards. Two other wooden hulls are now on the ways, one of which is expected to be launched in thirty days and the other in four months. The Slidell plant, which will shortly be one of the largest in the South, was for a number of years operated as the Slidell Drydock & Shipbuilding Company, engaged in the work of building barges and small vessels.

Extensive development in the yards already is under way for the building of a number of large composite ships. In order to provide for the new requirements there are now being constructed a fabricating shop for ship steel, brick warehouse, joiner shop, blacksmith shop, machine shop, sheet iron works for the plumbing department, pipe-fitting department and equipment for coppersmiths, electricians and riggers.

Ship Timber Wanted

The Committee on Public Information at Washington announces that wooden shipyards building ships for the Government are in the market for extra large white oak construction timbers or logs of good quality. The ships of the 2,000-ton type now being built for the Government each require two rudder posts of this species, 14 by 24 inches, 40 feet long. Logs measuring 28 inches in diameter at the small end were valued at the end of August at from $50 to $60 per thousand board feet, measured in the log. Sticks, hewed or sawed, on this size, $70 to $80 per thousand board feet, loaded on the cars under 200 miles from the shipyard. These prices apply to the South Atlantic and Gulf yards. Those having such timbers can obtain a list of Eastern shipping firms upon application to the Forest Service, Department of Agriculture.

Standard Oil Craft Navigates Yangtze Rapids

The Standard Oil Company's new steamer, the *Meitan,* arrived July 7 at Chungking, China, from Ichang, with a lighter carrying American kerosene, according to a report from the American Consul. The trip was made in four days, at a period when the rapids of the Yangtze River are very dangerous. It is the first time an American merchant ship has made the journey. This same vessel attempted it some time ago, but rudder trouble developed on the lighter accompanying the steamer, and it was necessary to put back for alterations to Shanghai, where the steamer and lighters were built. The only other merchant vessels at present running between Ichang and Chungking are owned by Chinese and fly the Chinese flag. It is reported that the Asiatic Petroleum Company, a British firm, intends to put a steamer especially designed for the rapids on this run.

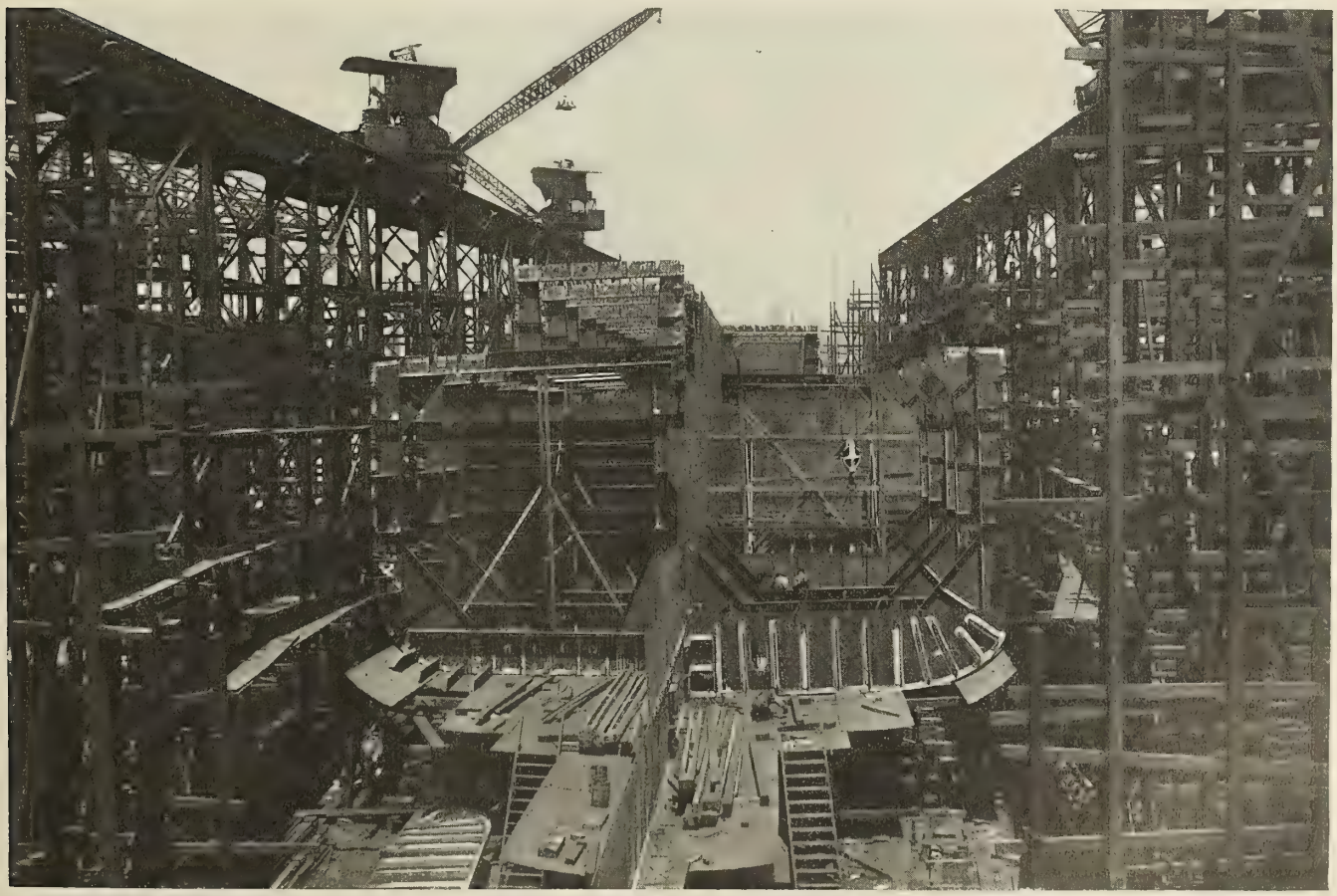
Vessel Launched This Year

The construction of the *Meitan* was commenced on October 1, 1916, by the Kiangnan Dock & Engineering Works at Shanghai. The vessel was launched on March 19, 1917. It was especially designed to meet conditions in the gorges and rapids of the Upper Yangtze between Ichang and Chungking, which for a long time was believed unnavigable for steamers. This ship can tow two lighters, one on each side, carrying bulk and case oil. It is believed that it can operate eight months of the year.

The steamer's dimensions, etc., are: Length over all, 140 feet 6 inches; length between perpendiculars, 135 feet 6 inches; breadth, 17 feet 6 inches; draft, normal, 5 feet 6 inches; steel construction; speed, 14 knots; machinery, engines, two triple-expansion reciprocating; boilers, two White Forster water-tube; auxiliaries, all independent; horsepower, 1,450.

(Photograph Copyright by International Film Service, Inc., N. Y.)

Damaged German Ship Being Overhauled and Fitted Out as Transport at American Port



Oil Tanker Construction at Union Iron Works, San Francisco, Cal.

Application of Law Requiring Inspection by U. S. Officers of Foreign-Built Vessels Admitted to American Registry Suspended by the President for Period of Two Years

The Department of Commerce has made public the following general orders to the Bureau of Navigation, the Steamboat Inspection Service, collectors of customs, local inspectors and others concerned:

"Your attention is called to the following Executive order, by which you will be governed:

EXECUTIVE ORDER

In pursuance of the authority conferred upon the President of the United States by section 2 of the act approved August 1, 1914, entitled "An act to provide for the admission of foreign-built ships to American registry for the foreign trade, and for other purposes," it is hereby ordered:

That the provisions of law requiring survey, inspection and measurement by officers of the United States of foreign-built ships admitted to United States registry under said act are hereby suspended, so far and for such length of time as is herein provided, namely: The said provisions shall not apply to any such foreign-built ship during the period of two years from September 1, 1917, provided the Secretary of Commerce is satisfied in the case of any such ship that the ship is safe and seaworthy and that proper effort is being made to comply with the said provision.

WOODROW WILSON.

The White House,
September 7, 1917.

"Respectfully,
"E. F. SWEET,
"Acting Secretary."

The following explanation of the above is furnished by the Steamboat Inspection Service:

"The Executive order of September 1, 1916, so far as the inspection of foreign-built vessels admitted to American registry is concerned, extended for one year from that date, the period within which such vessels would be required to comply with all of the provisions of the Steamboat Inspection Service, with reference to inspection.

"The Executive order of September 1, 7, 1917, extends for two years from September 1, 1917, the period after which such vessels must comply in all respects with the Steamboat Inspection Service laws, and during such period the provisions of law requiring survey, inspection and measurement by officers of the United States of such vessels are suspended, provided the Secretary of Commerce is satisfied in the case of any such ship that the ship is safe and seaworthy, and that proper effort is being made to comply with the said provisions."

New York and New Jersey Port Development Commissions Organize

The two commissions appointed by Governor Whitman, of New York, and Governor Edge, of New Jersey, to investigate conditions of the port of New York, organized on August 23 by electing William R. Willcox and J. Spencer Smith, chairmen of the two commissions. Gen. George W. Goethals was appointed chief consulting engineer. The commissions will report to the New York and New Jersey Legislatures. On the New York commission are William R. Willcox, E. H. Outerbridge and Arthur Curtiss James, while on the New Jersey commission are J. Spencer Smith, De Witt Van Buskirk and Frank R. Ford. Offices will be established at 115 Broadway.

An attempt will be made to solve the problems presented by the congestion of freight at the port of New York, and to agree upon a joint report, recommending a policy to be pursued by the States of New York and New Jersey and the United States, to the end that the port shall be efficiently and constructively organized and furnished with modern methods of piers, rail and water and freight facilities, and adequately protected in the event of war.

The legislation granting Governor Whitman power to appoint a commission to co-operate with a similar body created under a bill passed by the New

(Photograph Copyright by Edwin Levick, N. Y.)

Shipment of Grain—the Most Vital of all Staples in War or Peace—Being Loaded on Ward Liner

(Photograph Copyright by Press Illustrating Service, N. Y.)

Shipping in Naples Harbor, Showing Italian Forts in Background

Jersey Legislature, was the result of a special message to the Legislature on March 12, after a conference with Governor Edge of New Jersey and the State Engineer of New York. At this conference it was pointed out that the handling of freight in this port is a national concern, which requires the working out of a comprehensive policy for the intensive use of the port's facilities.

New Shipbuilding Companies Organized

The Redman-Vane Shipbuilding Company has been organized in Baltimore, Md., by J. C. Redman and A. P. Vane.

The Glynn Shipbuilding Company has been organized in Brunswick, Ga., for the purpose of building wooden ships.

The Construction & Dry Dock Corporation has been organized by Walter C. Cabell, Cornelius C. Moore and Walter Curry, Newport, R. I., for the purpose of building a shipyard at Portsmouth, R. I.

Wood & McClure, City Island, N. Y., have opened a ship and yacht repair shop at Mystic, Conn.

The United States Shipbuilding Company, will build a shipyard in Portland, Me., where it has leased a site of 12 acres.

The Wilmington Shipbuilding Company, Investment building, Los Angeles, Cal., will build a shipbuilding plant, and is stated to have received a contract from the Government to build several vessels.

The King & Winge Shipbuilding Company has been organized in West Seattle, Wash., by Thomas J. King and B. & C. B. Winge.

New York Waterways Association Meets

The eighth annual convention of the New York State Waterways Association will be held at Utica, N. Y., on October 4 and 5.

Resolutions will be considered relating to the waterways of the State, including canals and their possible uses by the Federal Government, canal terminals, inland navigable waters, tide waters, river and harbor improvements, the conservation and development of water powers and other matters covered by the declaration of the principles and objects of the association.

Shipyards Active in British Columbia

Shipbuilding in British Columbia has become an important industry. It is reported that contracts for steel and wooden vessels to the value of more than $27,000,000 have been awarded recently.

Among the concerns which are building ships, or which have contracts for them, are: J. Coughlan & Son, Vancouver; the Wallace Shipyards, North Vancouver; the British Pacific Engineering Company, Vancouver; the Taylor Engineering Company, Vancouver; the Whalen Pulp & Paper Company, Vancouver; Cameron, Genoa, Mills, Shipbuilders, Ltd., Victoria; the British Columbia Construction & Engineering Company, Poplar Island, New Westminster; the Pacific Construction Company, Port Coquitlam; Harrison & Lamond, South Vancouver.

Naval Course to Be Given at Yale

Yale University has added to its curriculum this year a course in naval training. The course will prepare students for the position of ensigns in the United States Navy, and will parallel the course in artillery training started last spring to train students for commissions in the artillery branch of the army.

The students will be allowed to take a three-year course to fit themselves for either army or navy commissions.

Ship Sale Nets $2,000,000 Profit

Over two million dollars profit was made on the sale of two of the Merchants & Miners Transportation Company's steamships. The ships are the *Somerset* and *Suwanee*, sold to the Ocean Steamship Company, of Savannah.

The two ships have been in service for over six years, but despite this fact they each sold for an individual profit of $1,010,000 more than they cost to build. This clearly indicates the high price being paid for tonnage.

Ferris Wooden Ship Design May Be Modified

Proposed changes in specifications of timber entering into the construction of the Government's fleet of wooden steamers, which will make possible the cutting of a much larger quantity of such material by Southern mills, may receive the serious consideration of the United States Emergency Fleet Corporation.

The Southern Pine Emergency Bureau has suggested to the Fleet Corporation the advisability of abandoning the present Ferris model of standard 3,000-ton wooden steamers, and the substitution of another which would make it much easier for sawmills to get out timbers that are required for ships, and which would also enable a larger number of mills to cut such timbers. The new specifications suggested call for shorter lengths and smaller sizes.

Boats of a similar capacity to the proposed Government ships are now being built on the Gulf of smaller timbers, and while the Emeregency Bureau was able to secure commitments for more than a sufficient number of mills to cover its blanket order of 100 complete schedules for the Ferris type of ship, the Bureau has stated to the Fleet Corporation that there would be difficulty in securing any considerable number of additional schedules on the original specifications. On the other hand, there would be no trouble in obtaining almost any number required if the specifications were modified as suggested.

Joint Committee Named to Study Concrete Ships and Barges

Robert W. Boyd, consulting engineer, has been retained by the Joint Committee on Concrete Ships and Barges appointed by the American Concrete Institute and the Portland Cement Association. The members of the two committees are as follows:

American Concrete Institute—H. C. Turner, chairman; Leonard C. Wason, Robert W. Lesley, Charles R. Gow, M. M. Upson.

Portland Cement Association—E. D. Boyer, chairman; Joseph Brobston, F. W. Kelly, W. S. Mallory, S. P. Crabo.

An active investigation has been undertaken to determine the possibility of this type of construction.

Canadian Shipyards Operated at Full Capacity

Canada is playing a big part in the shipbuilding industry of the world. No less than 74 steel boats of all kinds were under construction in the Dominion during July and August, these having a gross tonnage of 126,949. Of these, 25 are being built on the Atlantic coast, 30 on the Great Lakes and 19 on the Pacific coast. These do not include the large number of sub-chasers and other boats being regularly shipped to Britain by Canadian shipbuilding concerns.

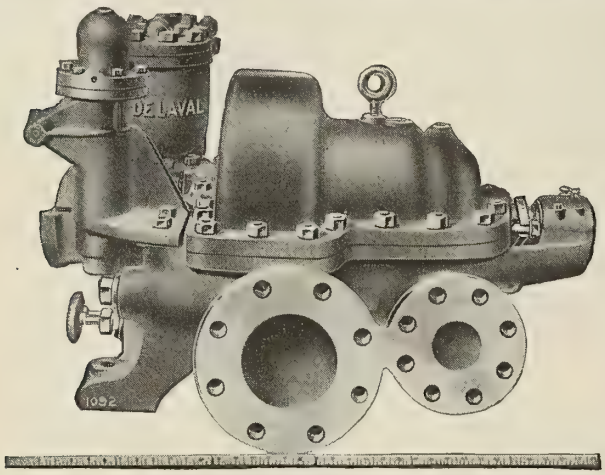


Fig. 1.—3,000 Horsepower, Two-Stage, Centrifugal, Turbine-Driven Boiler Feeder

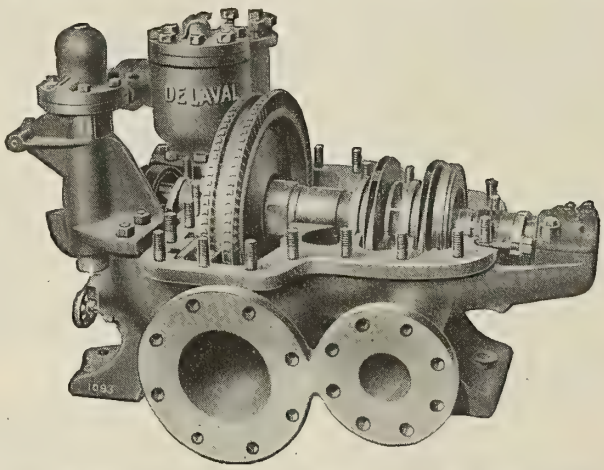


Fig. 2.—Turbine-Driven Boiler Feeder, with Casing Removed, Showing Moving Parts

Mobile to Have Municipal Docks

By an overwhelming majority the citizens of Mobile, Ala., voted on Aug. 13 to authorize the City Commission to arrange a bond issue of $600,000 for the construction of a municipal water terminal. The project as designed comprises concrete wharves, piers and bulkheads, railroad connections to the water front and dredging to a depth of 30 feet. Warehouses are also included in the design, but cannot be built within the present appropriation.

Combined Steam Turbine and Centrifugal Boiler Feed Pump

Since it must handle a comparatively small amount of water against a relatively great head, the centrifugal boiler feed pump should be fitted with small diameter impellers running at high speed. It is therefore well accepted for steam turbine drive.

A development in the direction of compactness and simplicity is shown by Figs. 1 and 2, illustrating a 3,000-horsepower, two-stage centrifugal boiler feeder combined in one casing and one shaft, with a velocity-stage steam turbine. This unit, which has been developed by the De Laval Steam Turbine Company, Trenton, N. J., weighs only about one-tenth as much as a duplex reciprocating pump of the same delivery, and occupies only about one-eighth as much floor space and one-fifteenth as much cubical space.

The pump end contains two single-suction impellers cast from a special bronze and carefully finished to exact contours. Two impellers are used for pressures up to 200 pounds per square inch, and three impellers for higher pressures. Single-stage boiler feed pumps have been built, but two or three stages are preferable, because of the much longer life of the impellers at slower speeds. Each impeller discharges into a volute chamber, by means of which the velocity in the water as it leaves the impeller is converted into pressure before the water is led to the eye of the succeeding impeller. This means of energy conversion is superior to the use of diffusion rings, as it is efficient over a wide range of delivery and, more important still, does not involve the use of small and sharp parts like diffusion blades, which are subject to rapid erosion.

The pump is hydraulically balanced, and only one pair of labyrinth rings, surrounding the suction opening, is required for each impeller except the last, which has two sets of rings. The whole back of the impeller is subjected to a pressure equal to that existing at the periphery of the impeller, the same pressure acting on the front of the impeller, except for the area of the circle enclosed by the labyrinth ring about the suction opening. The last impeller, that is, the one from which the water is finally discharged, is equipped with two sets of wearing rings, one on the suction side and one on the reverse side of the web. As some water from the discharge of this impeller will leak between the wearing rings into the space back of the web, this impeller would be equally as unbalanced as the other impellers in the pump if there were no escape for the leakage water. To provide for diminishing the pressure in this balancing space as much as may be required to bring the whole series of impellers into balance, a leakage outlet is provided from which water can be conducted back to the suction of the first impeller.

The outlet leakage takes place between two collars, one attached to the casing and the other carried on the shaft. When the shaft moves towards the discharge end of the pump this escape is closed off and the pressure builds up in the balancing chamber. If the shaft, on the other hand, moves toward the suction, this escape passage is opened wider, allowing the pressure in the balancing chamber to fall, and at the same time the inleakage between the labyrinth wearing rings is decreased. By this means direct and positive balancing within very close clearance is

secured with the leakage of but a small amount of water.

The reduction of leakage secured by the use of intermeshing labyrinth rings is highly important for securing high efficiency in pumps of comparatively small delivery. With the labyrinth type of rings the leakage path is so tortuous that very little water escapes even at high heads, although ample clearance is provided to take up expansion and contraction due to changes in temperature.

The suction end of the pump is adjacent the turbine, and the shaft packing between the turbine and pump chamber is hence subjected to turbine exhaust pressure on one side and the suction pressure on the other. A simple packing is therefore sufficient, and, in any case, any small leakage of steam in one direction or of water in the other does no harm. As the leakage space adjacent the balancing chamber at the discharge end of the pump is connected back to the pump suction, the packing about the shaft is subjected only to suction pressure. Aside from the intermediate packing already mentioned, there is only one steam packing which is subjected to exhaust pressure.

The steam end of the unit consists of a velocity-stage turbine, with either two or three rows of moving buckets, according to the steam economy desired. The nozzles can be proportioned for either high-pressure steam exhausting to feed heater, or to condenser or for low-pressure steam exhausting to condenser, or the unit can be made interchangeable, thus permitting of a great degree of flexibility in plant design. Where the exhaust steam from the boiler feed pump is consumed in heating feed water, the thermal efficiency of the turbine-driven boiler feed pump is much greater than that of a pump driven by electric motor, or even that of the main unit itself.

The unit is ordinarily fitted with a speed governor mounted upon the end of the shaft, and when running at constant speed the head varies with the delivery. To provide against any possibility of racing, an emergency governor is also fitted. This consists of a pin contained within a hole bored diametrically through the shaft. This pin is held by a spring from flying out under the influence of centrifugal force. When the speed reaches a certain point the spring is compressed so that the pin strikes a trip, releasing another spring, by which the governor valve is closed at once and completely. The normal speeds of these pumps vary from 1,800 to 3,500 revolutions per minute, according to pressure and capacity, and due to the heavy shafts employed are far below the critical speeds.

In specifying the capacity of boiler feeders, the temperature of the water to be pumped should always be stated, as the capacity is nearly 50 percent greater with water at 75 degrees F. than with water at 210 degrees F. For the same reason capacity and efficiency tests of a pump should be carried out with water at the temperature at which it will be received by the pump when in actual service.

Automatic Starters for Induction Motors

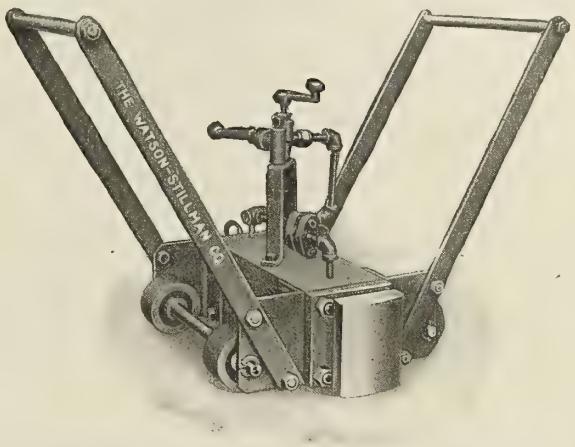
In order to aid manufacturers in their efforts to increase production and reduce operating expenses, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., is manufacturing automatic starters and controllers for motor-driven machinery. These automatic starters are for use with single-phase or polyphase squirrel cage and wound-rotor induction motors, where it is desired to start the motor from a remote point, or where automatic acceleration is required to guard against improper starting by unskilled operators. They are simple, reliable and rugged in construction, consisting of a magnetic contactor panel and a master switch, which may be either a push button, a float switch, a pressure regulator, or similar device for closing the control circuit, depending upon the service. The vital element is the magnetic contactor. The contactors used on these starters are of a type which has been used by the Westinghouse Company with marked success in steel mill, cement plant and mine installations where the requirements are extremely severe. The contactors are opened by strong spring action assisted by gravity. The destructive action of the arc is reduced to a minimum by strong blowout coils and arcing horns. The operation of the starters is very simple.

The advantages resulting from the use of automatic starters for induction motors comprise absolute protection to both operator and expensive machinery, proper starting at the most rapid permissible rate, economy in operation and maintenance, convenience of remote control, and automatic operation.

Portable Bending Machine for Steel Shapes

The Watson-Stillman Company, New York, has brought out a new tool for use in shipbuilding, designed to bend heavy steel shapes for ship frames, deck beams, etc. It is a very compact machine, built as light as consistent with the work it is intended to do. The machine consists of a cylinder, ram and operating valve, mounted upon broad rollers so that it may be moved quickly over the bending slabs by handles at either side of the machine. It is thus possible to bend long members to template without reheating and with a minimum of labor.

A loose pin is provided which fits into the holes in the bending slabs, and serves as an abutment for the machine. The ram is double acting, and its movement both forward and returning is under perfect control at all times. Provision is made to prevent overstroke. The illustration shows the machine equipped with a screw stem stop and release valve, but a single lever operating valve can be furnished if desired. Power may be supplied from a suitable pump, or preferably from an accumulator service. The machine is built as shown with a movement at right angles to the axis of the ram, or in a direction parallel to it.



Portable Machine for Bending Bars and Shapes

The machine illustrated has a 10-inch stroke and develops 18 tons at 1,500 pounds per square inch, and 20 tons at 1,750 pounds per square inch pressure. It weighs 750 pounds.

Personal

Henry J. Roundy, formerly assistant marine superintendent of the Lake Torpedo Boat Company, Bridgeport, Conn., has been appointed chief construction inspector for the United States Shipping Board Emergency Fleet Corporation, Southern District, with headquarters at Houston, Texas.

H. E. Hilts, formerly district engineer at San Francisco for the Portland Cement Association, has been elected by the Board of Directors of that body to succeed the late Mr. J. P. Beck as general manager.

Obituary

George W. King, president of the Marion Steam Shovel Company, Marion, Ohio, died on September 9, aged sixty-three. Mr. King had been connected with the company since its formation in 1884 and had been its president since 1904.

John H. Morrison, of Brooklyn, N. Y., died recently at his summer home in Ocean Grove, N. J., aged seventy-six. By profession Mr. Morrison was a naval architect, but is best known to the marine world as an historian. He was the author of "History of American Steam Navigation," first published in 1903, and which is one of the most complete and reliable compilations of American steam navigation available. Mr. Morrison was also a frequent contributor to this journal, his latest contribution, published only a few months ago, being on the subject of the development of oil tankers in America.

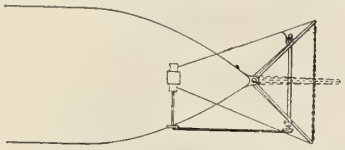
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,223,416. SHIP BRAKE. THOMAS O'SULLIVAN, OF MONTREAL, QUEBEC, CANADA.

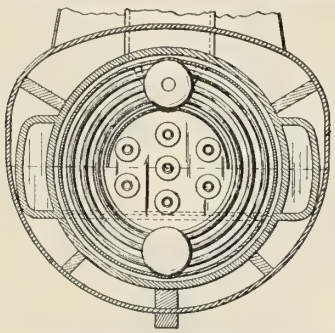
Claim 1.—Ship brake, comprising a pair of plates hingeably secured to the stem of a ship, a right and left screw passing through the



plates, and nuts operating on said screw pivotally mounted on the plates, and means for rotating the screw. Three claims.

1,224,105. WATERTUBE BOILER FOR SUBMARINES. GREGORY C. DAVISON, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.

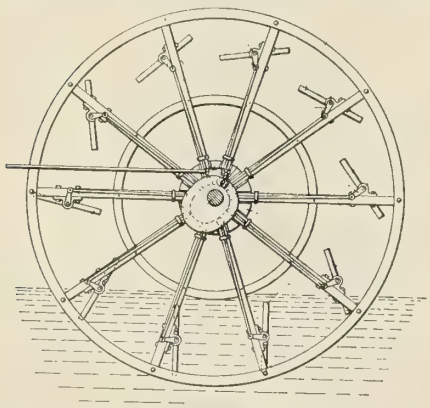
Claim 1.—In a submarine boat, in combination, an inner hull, an outer hull, a closed compartment within the inner hull, a watertube boiler located in said compartment and a fore-and-aft arranged thoroughfare compartment alongside the boiler compartment, the thorough-



fare compartment extending forward and aft beyond the forward and aft ends of the boiler compartment, and openings in the inner hull forward and aft of the boiler compartment for affording direct communication to the thoroughfare compartment. Fourteen claims.

1,225,287. FEATHERING PADDLE-WHEEL. OSCAR E. THOMPSON, OF HADLOCK, WASH.

Claim 1.—A paddle-wheel, comprising in its construction spokes, paddles provided with pintles whereby the paddles are pivotally connected to the spokes, a crank on each of said



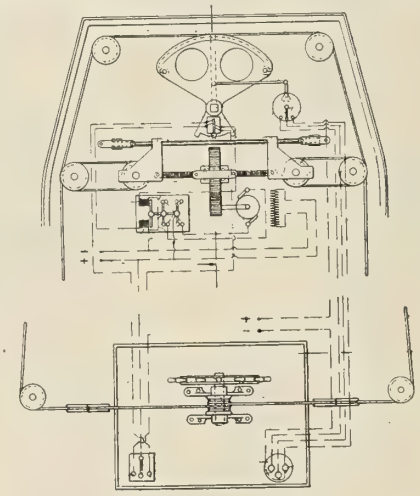
pintles, a cam formed with a web member and two spaced flanges extending laterally therefrom, said web member being provided with an opening between said flanges, a series of rollers operable against the opposing surfaces of said flanges and adapted to be introduced or removed through said openings, rods connecting said rollers with the respective cranks, and means provided on the spokes and serving to direct the rods whereby the rollers are caused to revolve with the wheel to effect the tilting movements of the various paddles through the agency of said cam flanges. Two claims.

1,202,519. APPARATUS FOR SECURING LINES TO SUNKEN VESSELS. DAVID W. HIVELY, OF SEATTLE, WASH., ASSIGNOR OF ONE-HALF TO ENOS B. CADE, OF SEATTLE, WASH.

Claim 6.—A device comprising, in combination, means operable from the surface for bolting a plate having a line attached, to the hull of a submerged vessel, means for propelling the device, means for directing the device toward a vessel, and magnets for securing the device to the vessel while said plate is being bolted in position. Twenty-six claims.

1,225,913. RUDDER CONTROL. FRANK W. WOOD, OF MONTCLAIR, N. J., ASSIGNOR TO CHARLES CORY & SON, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—The combination with the rudder of a vessel, a manually operable steering element, and tiller connections extending between the rudder and said element for producing rudder movements, of power mechanism in perma-

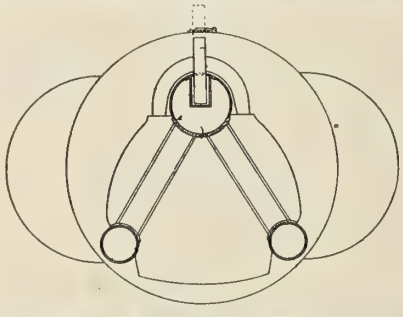


nent operative engagement with said connections intermediate the rudder and steering element and adapted to produce rudder movements when the mechanism is active and when said element is held stationary, the length of the connections between rudder and steering element remaining constant during mechanism operation. Six claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

104,318/16. "IMPROVEMENTS RELATING TO FUNNELS OF SUBMARINE VESSELS." H. E. YARROW, OF MESSRS. YARROW & CO., LTD., OF SCOTSTOUN, GLASGOW, SCOTLAND, ENGINEER.

The funnel is made telescopic, and when the vessel is submerged is lowered into a receptacle



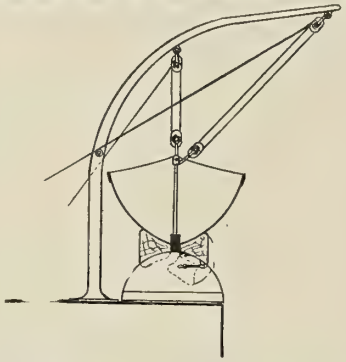
provided in the steam drum. The housing of the funnel in the steam drum also provides a firm foundation for the base of the funnel to rest upon when it is in the housed position, and has to be made water-tight.

104,610/16. "AN IMPROVED EMERGENCY PATCH OR BREACH COVER FOR USE ON SHIPS." W. MATHEWS, OF MAES-Y-LLAN, TONNA, NEATH, SOUTH WALES, BLACKSMITH.

The emergency patch or breach cover consists of a plate of aluminum covered upon one side with sailcloth and carrying strips of aluminium for additional strength, one such strip being across, at or near the top, another one at or near the bottom, and another such strip or strips across the middle or otherwise between the top and bottom, also a number of steel ropes attached in pairs perpendicularly upon the plate, each pair fastened to a pulley on the top and a ring on the bottom, and finally a bridle on the plate for enabling it to be drawn from place to place by a winding rope.

102,213/16. "METHOD OF LAUNCHING BOATS FROM SHIPS AT SEA." E. T. JACKSON, OF 9, WILSON STREET, MIDDLESBROUGH, IN THE COUNTY OF YORK, MASTER MARINER.

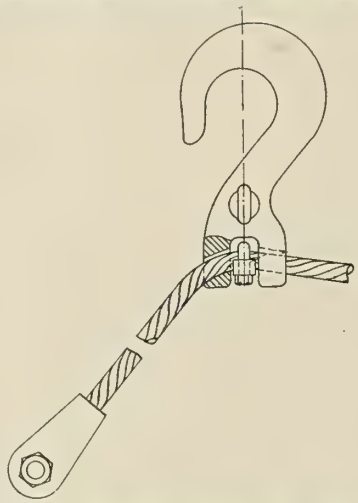
This method and means for supporting and lowering boats consists of two semi-circular boat stands fixed to the deck, each provided



with a fixed chock and a hinged chock held in position by lever actuated pin in combination with two lengthened fixed davits supporting inner and outer tackles.

104,814. "IMPROVED MEANS OF SLINGING NESTED BOATS." P. D. MURRAY, OF WINDYMERE, MOOR LANE, GREAT CROSBY, IN THE COUNTY OF LANCASTER, MASTER MARINER AND MARINE SURVEYOR.

This invention relates to improved means of slinging nested lifeboats and to the provision of a special design of slings and hooks for same. Each sling is arranged longitudinally of the nested boats and is carried by or secured in the specially designed hook or eye, which is provided with an inverted U-termination through each leg, of which an orifice is formed



to receive said sling; within the recess so formed is arranged a locking clamp consisting of a staple shaped clip passing over the sling, whose free ends are threaded and bolted through a block having grooves therein for engaging the strands of wire rope; compression is thus applied by the nuts so securing the hook or eye in any desired position on the sling. Small eyes are provided on each side of the hook to receive the guy chains, which pass laterally to the longitudinal stringers on each side of the boat.

106,534. "IMPROVED BREACH MAT FOR CLOSING LEAKS IN SHIPS AND BOATS." A. R. M. SANKEY, OF POLYGON HOUSE, SOUTHAMPTON, IN THE COUNTY OF HANTS, AND A. J. SMITH, OF "EDGEHILL," PEAK HILL, SYDENHAM, IN THE COUNTY OF LONDON.

This invention relates to breach mats for closing leaks in ships and boats and of the type which is constructed of elastic waterproof material reinforced by linked metallic slats, sufficient flexibility being secured in order that the mat may be free to conform to the profile of the hull. The objects of the invention are speed in the application of the mat to the side of the ship, improved means whereby the mat is adapted to conform to the curvature of the hull, and ease in manipulation.

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Ships, Shipbuilders and Seamen!

"WHATEVER other contribution we may make to the prosecution of the war, that of ships must be first, because it is only by means of ships that other contributions can be successfully delivered."—*James A. Farrell, president, United States Steel Corporation.*

"It has become apparent to most of us in this war that the success of our efforts, the amount of force we can put into the war, depends not alone upon the army or the navy, and not alone upon any department of the Federal Government. To win the war requires the enthusiastic support of the great bulk of the people of the country in a very important industry. . . . The output of ships in American shipyards depends more upon the supply of labor and the continuous employment of that labor than any other fact. The use of these ships, when once built, is going to depend more upon the supply of seamen and officers and the services of longshoremen in loading and unloading them than any other factor in the situation."—*Raymond B. Stevens, vice-chairman, United States Shipping Board.*

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Speed Up the Emergency Fleet

ALTHOUGH plans for the standard steel fabricated ships, which will form a large part of the Government's emergency fleet, were fully developed last June, it was not until a month ago that contracts for the construction of any of these ships were placed, and construction of the three great yards in which they will be built has now only just begun, while the laying of the first keel is still a matter of the future. Enormous as these projects are, a delay of from three to four months in the initial stages of their development through differences between the Shipping Board and its subsidiary organization, finally resulting in an almost complete change in the personnel of the two bodies, is a matter that can be condoned only by putting forth every effort for the speeding up of production now that the work is actually begun.

When the Government emergency fleet was first proposed the former chairman of the Shipping Board predicted that the first of the standard wooden ships would be available for service by November 1, and that after that date the fleet would rapidly increase week by week. As a matter of fact, not one of the Government standard ships, of either wood or steel, is yet in the water, and the earliest deliveries cannot be expected before next spring.

So much for the delays which sometimes appear inevitable in a national crisis by the clogging of Government departmental machinery with misfits, incompetency and political interference. Since harmony has been restored, the outlook is brighter. Vast improvements in the speed of production have already been made by many of the older and some of the new shipyards, and the ships under contract that were commandeered by the Government are coming off the ways in increasing numbers every week. To speed up and promote in every way the country's shipbuilding the Shipping Board has appointed a special production board, consisting of Charles Piez, president of the Link Belt Company, Chicago, chairman, and Charles Day, electrical engineer, Philadelphia; Arthur Mason, erecting engineer, Chicago, and Frank Kirby, naval architect, New York. In surveying the shipbuilding field this committee is authorized to recommend any improvements in methods of construction or in shipbuilding materials which will eliminate delays. Increased production from now on, however, will undoubtedly depend far more on the labor question than upon the question of shipbuilding facilities or supplies. In fact, shortage of labor and labor troubles form the most important obstacles now facing the Government shipbuilding programme.

A New Era in Shipbuilding

GREAT BRITAIN built her first 8,000-ton standard steel ship in less than six months, and it is predicted that later vessels of the same class will be produced in from four to four and a half months. An 8,800-ton steel cargo steamship was recently turned out in an American shipyard in less than five months, but it remains for the actual building of the fabricated steel ships in the new Government yards now being erected to show what is actually possible in the rapidity of production of standardized steel ships. If expectations are fully met, and there is every reason to believe that they will be, if not surpassed, a new era in shipbuilding, and one that is characteristic of American enterprise and ingenuity in gigantic intensive building operations, will have dawned.

In the case of the fabricated ships, contrary to the usual practice in shipbuilding, 82 percent of the hull work, including riveting, will be completed in structural steel shops inland, so that when the fabricated parts of the ship reach the shipyard on the seaboard only 18 percent of the work will remain to be done in erecting the ship. Not only will accurate molds and templates of every plate and shape in the vessel be supplied to the structural shops, so that every piece of metal that goes into the ship, including such parts as the bossing around the stern tube, can be accurately cut, shaped and punched in the shops, but also as much of the riveting as the limits in size of fabricated sections that can be transported to the seaboard will allow will be done at the structural shops. The work at the yards, therefore, is reduced to the erection and riveting of the fabricated sections.

To aid in the speed of fabrication, the model of the ship is such that a maximum amount of straight line work is involved, the usual sheer and camber of decks, an inheritage of the early wooden shipbuilding days, being discarded and structural shapes substituted for the special shipbuilding shapes. In the case of the machinery, contracts are

let to an engine builder for the complete equipment for the engine room, including the main propelling engines, shafting, auxiliaries and piping to be delivered accurately fitted and ready for installation in a minimum of time. Similarly, the complete equipment of the boiler room, including the boilers, auxiliaries and piping, is to be supplied under one contract by the boiler manufacturer, ready for immediate installation in the ship.

Under this scheme the shipyard with a maximum number of building ways and adequate transportation facilities and appliances for handling material becomes simply an assembling or erection yard, depending for its success upon a carefully planned schedule for the fabricating of the various parts of the structure with extreme accuracy and for their delivery at the shipyard at exactly schedule time, which differs little except in volume from the kind of work which the steel structural shops of the United States have been carrying out successfully for years in connection with bridge and other structural work.

Lloyd's Approval of Concrete Ships

LLOYD'S recent approval of plans for the construction of several reinforced concrete ships with a view to classification by the society means that the ferro-concrete, seagoing, self-propelled vessel has become—within certain limits of size—a practical proposition. Now that the basic principles upon which this form of shipbuilding rests have been fully accepted, the problem resolves itself into a question of how far such a design may be developed safely in its application to larger ships. The plans already approved by Lloyd's cover a number of non-propelling barges, some of which are designed to carry as much as 500 tons deadweight, and a motor vessel for coastwise trade between Great Britain and Scandinavian countries. These vessels will be built in the United Kingdom and Norway under the inspection of Lloyd's surveyors and plans for other similar vessels, but of larger carrying capacity, are now under consideration.

The Nine Million Dollar Plant At Fore River

THE new plant of the Fore River Shipbuilding Corporation located a few miles south of Boston, will, in the course of a few months, be the greatest destroyer plant in the world. It will be erected by the Aberthaw Construction Company, of Boston, at a cost of over $9,000,000 (£1,850,000).

This is by far the biggest thing of its kind ever attempted in the United States, particularly in view of the fact that the plant will be practically finished at the beginning of 1918. The complete development will comprise a large number of small destroyer slips and the necessary manufacturing buildings, the latter having an aggregate floor space of more than 2,000,000 square feet.

To gain some idea of this tremendous undertaking compare it with the contracts for building the great army cantonments, the largest of which was two million less than the job just awarded the Aberthaw Company. It should also be noted that the present development is a permanent proposition, the work being almost entirely reinforced concrete, whereas the cantonments were temporary structures built mostly of wood.

After the completion of the plant the programme calls for delivery by the Fore River Corporation within two years of at least 46 destroyers. These will cost $1,500,000 (£308,000) each, or a total of $69,000,000 (£14,168,000).

In addition to the main plant outside of Boston, there will be erected a $2,500,000 turbine plant at Buffalo, N. Y., and another $1,500,000 plant in Providence, R. I. The equipment from these plants will be shipped to Fore River as soon as completed.

The construction of the plant itself will require more than 4,000 men, and the Aberthaw Company plans on having this full quota on hand by November. For the construction of the ships themselves the Fore River Shipbuilding Corporation will need from 8,000 to 10,000 men at Quincy, 3,500 at Buffalo, and 1,000 at Providence. They will endeavor to obtain part of the necessary quota by offering positions to Aberthaw men who are at present working on the construction of the plant.

Material for the ships will not be lacking, since the priority board has given the destroyer builders preference over all other concerns working for the Government, even over shipbuilders constructing the merchant fleet. Furthermore, the Carnegie Steel Company has rolled steel for thirty-two destroyers in two months, and can, therefore, readily make delivery for the ships to be built under the new programme.

The Return to the Reciprocating Engine

ONE of the most interesting features in connection with the new shipping programme is the wholesale return to the reciprocating engine as a main drive. This coming immediately after the successful demonstration of the advantage of gear turbine drive makes this point all the more noticeable. The answer, from what we can learn, lies in the fact that the gear-cutting capacity of the country is taxed to the limit. Deliveries are therefore prohibitive, whereas many plants are in a position to turn out reciprocating engines on record time.

While this is all very true with regard to prime movers, the same arguments cannot be advanced in regard to the auxiliaries, yet there seems a marked tendency throughout the present programme to adhere to reciprocating sets exclusively. Reliability is paramount in all marine work. Our own and foreign navies have appreciated this, and have switched over from reciprocating engines to turbines wherever possible for this one reason. The merchant ships that will sail the war zone will be equipped with apparatus, such as forced draft fans, that will be called upon to start up from rest at a moment's notice—and keep running. The turbine is obviously better adapted for this duty than the reciprocating engine.

Among the arguments one hears advanced as to why reciprocating engines should be used in this new programme is that the operating engineers will be more accustomed to them than to turbines. But will the man that will necessarily be called upon to operate these be really experienced with any types of engine? It would appear that with the present scarcity of skilled labor and the draft we will be compelled to man our ships to a great extent with green men. These men will have to be educated: then why educate them primarily in an obsolete school? Again, it has always been our impression that the modern small turbine requires much less attention than a reciprocating engine. If attention is needed for a reciprocating engine, will these green men be capable?

From an efficiency standpoint there exists a considerable difference of opinion as to what is the best type of apparatus to install. We quote from an article published by the Society of Naval Engineers in 1912 in connection with comparative tests that were made at Annapolis on turbine versus reciprocating pumps: "When pumping warm water there is little difference between the economy of this centrifugal pump and the simplex pump." It is true that the pumps in question were of larger capacity than will be required for the merchant marine, but even if the reciprocating engine does show up better on test, the question of maintenance of the initial efficiency must

be considered. Quoting again from this same article: "Reciprocating pumps decrease steadily in efficiency, due to wear, while the centrifugal pump will probably change very little in this respect." Another point with regard to this efficiency question: if the exhaust can be utilized either in a feed water heater or the low pressure receiver, any net difference in efficiency between the two will have no appreciable effect on the coal pile. It is proposed to install forced draft sets in the emergency vessels for use in the war zone only. If the exhaust from these forced draft sets is led to the low pressure receiver, the pressure in this receiver will be automatically raised, which is just what is wanted for the higher speed requirements.

Regarding weight and space occupied, the turbine drive has unquestionably the advantage. For forced draft sets, for instance, if the figures we have before us are correct, there is approximately a saving of 1,000 to 1,500 pounds per boat. There is also a big saving in generator sets, but in forced draft sets, where it is proposed to operate them only as an emergency, the difference in water rate can be of no importance, and the saving in space and weight should, therefore, receive very serious consideration. The less weight and space taken up by machinery of any kind means that much more food for our own troops and those of our Allies.

It would be foolish for anyone to argue in favor of wholesale and indiscriminate adoption of steam turbines for all auxiliaries, but it would appear that the small steam turbine is not receiving the consideration it should for a lot of this work. First cost, of course, must enter into this argument. We have no figures on which to base any statement, but from figures from other installations with which we are acquainted it would appear that the turbine should have the advantage. However, this is purely a commercial proposition and must be decided between the shipbuilder and manufacturer.

What is the Operating Engineer to Expect from Superheating?

FOR the operating engineer, the man who has "to sleep with the job," the average marine engine, working with saturated steam, possesses no uncanny properties. What, then, will happen when his vessel is converted to superheated steam operation or he is transferred to a vessel so designed and constructed? Is he to be called upon to be shipmates with an engine that is possessed of peculiarities, in dealing with which his former experience counts for but little? It may prove interesting to see just what he is going to experience.

In raising steam an occasional opening of the drains on the superheater headers will be the only additional change in the usual procedure. With steam up on all boilers, the main stop valves are all opened, and steam passes through the superheater pipes, going to the throttle at a temperature some 200 degrees higher than when it left the main stop. On opening the throttle, the familiar "mushy" sound of the steam passing to the engine is missing, instead one hears the distinct hiss of absolutely dry steam, and as the vessel gains headway and revolutions increase, this change becomes more noticeable.

It frequently happens that the engine that was formerly turning up 80 or 85 revolutions per minute is now turning up on an average of 82 to 87 revolutions per minute, and, whereas it was formerly necessary to open drains all around and at times impossible to close the low pressure drain for a considerable period, we find such procedure no longer necessary. It may be found necessary to speed up the circulating pump slightly to hold the surface condenser to its duty.

Perhaps the engineer has been accustomed to running with very snug rings and he is fearful lest these should "seize"; on the other hand, and if he slacks up on them he feels that he may have leakage and lose in efficiency. This same engineer will put saturated steam pressure on a line that he has seen leaking slightly under water pressure, well knowing that the line will prove tight under steam. In the same way a ring fit that would permit of steam leakage saturated will be steam tight under superheated steam.

To compensate for the lubricating moisture under saturated steam, his vessel is now equipped with a force feed oil pump, introducing oil into the engine at the high pressure chest. This oil, which should be high grade, superheater oil, is taken out by either a gravity or pressure filter, the cleaning of which calls for half an hour's attention every thirty-six hours in the case of some gravity device operating in conjunction with an engine developing 3,000 indicated horsepower. Twenty minutes' attention to the pressure filter (installed between the pump and the feed water heater) every four or five days will, in a similar manner, keep the boiler free from oil. This matter of oil in the feed is one that the average engineer views with suspicion, unless he is operating a jet condenser and the condensate is pumped overboard. The fact, however, that boilers can be kept entirely free from oil is not based on a few isolated installations, but upon the experience gained on something over 2,000 vessels manned by crews of all nationalities and in every form of service.

In the blowing of flues, the blower operates the same as with saturated steam, except that by using superheated steam in the operation, the flues are cleaned more satisfactorily and the accumulated soot is blown out as soot. When saturated steam is used for this purpose the soot is often impregnated with moisture and the greater bulk of that escaping from the flues deposits by gravity in the soot pockets, thereby stopping up the lower rows of flues.

Furthermore, the superheater elements, while offering retardation to the draft, do not present a surface that is as potent in depositing soot during the process of combustion as is that presented by the average three or four turn retarder. Such being the case, there is less accumulation of soot in the same period, when the flues contain superheater elements instead of retarders.

Suppose it becomes necessary to plug a flue, steam is shut off the superheater at the main stop or from that branch of the superheater on the affected portion of the boiler, the unit whose elements project into the disabled flue is withdrawn by unscrewing two nuts, dummy ends are inserted into the superheated and saturated headers, and the nuts again set up—altogether a ten or twelve minute operation.

By the use of packing suitable for high degree superheat no trouble will be experienced with leakage or the scoring of the rods. It should be borne in mind, however, that as in saturated jobs the packing should be carefully put in and set up.

To the up-to-date engineer, considering the fuel saving effected, the slight additional care required by the superheated plant is, or should be, a negligible item. The elements essential to the successful operation of marine prime movers, by highly superheated steam, are all available at the present time; i. e., a proper design of superheater; material to withstand this high degree of superheat and a grade of oil that will not lose its lubricating properties at high temperatures.

The Science of Naval Architecture*

Address Delivered Before the Franklin Institute by the Chief Constructor of the United States Navy—History of Development

BY DAVID WATSON TAYLOR, D. ENG.†

THE art of shipbuilding was undoubtedly developed at a very early stage of the history of the human race. The earliest record of a ship, as distinct from a boat, canoe or other small craft, is found in Egyptian carvings of a date about 3000 B. C. But the science of naval architecture, like so many other branches of science, developed slowly, this science, as now accepted, being mainly a development of the last hundred years—we may almost say of the last fifty years.

The famous Swedish naval architect and shipbuilder, Henry de Chapman, published a treatise on shipbuilding in 1775. As late as 1820 we find Doctor Inman, the head of the Royal Naval College and School of Naval Architects in Portsmouth Dockyard, England, publishing a translation of Chapman for the instruction of English students of naval architecture. Chapman's work, so far as it deals with the science of naval architecture, consists largely of empirical rules, although it was far in advance of his day, and much of it is still applicable to sailing ships. In some respects his ideas were largely erroneous, an example being his theories regarding resistance of ships. In fact, it was not until a hundred years after Chapman's time that the science of naval architecture was enriched by sound theories concerning this important branch.

In Ruskin's Day

Dealing with the sailing vessels concerning which Chapman wrote, Ruskin said:

"Take it all in all, a ship of the line is the most honorable thing that man as a gregarious animal has ever produced. By himself, unaided, he can do better things than ships of the line; he can do poems and pictures and other combinations of what is best in him. But as a being living in flocks and hammering out with alternate strokes and mutual agreement what is necessary for him in those places, to get or produce the ship of the line is his first work. Into that he has put as much human patience, common sense, forethought, experimental philosophy, self-control, habits of order and obedience, thoroughly wrought handiwork, defiance of brute elements, careless courage, careful patriotism, and calm expectation of the judgment of God as can well be put into a space 300 feet long and 80 feet broad, and I am thankful to have lived in an age when I can see this thing done."

This is what Ruskin thought and wrote years ago of the ship of his day. His words are even more true of the ship of our present day and generation. His 300 feet of length has trebled, and the size of such a ship, as measured in terms of weight, has grown nearly ten times. These modern ships have been made possible by the development of the science of naval architecture. This science, alone and unaided, without parallel development in practically all of the arts, sciences and trades, could not have produced these ships; but, so far as the ship itself is concerned, all the great progress in every branch of science and industry could not have produced this concentrated embodiment of human intelligence without the development and advancement of naval architecture or the theory of shipbuilding, a branch of applied science which calls upon and draws from an exceptional number of the arts and sciences.

The modern battle cruiser, whose building is just being undertaken in this country, is an excellent example of the mutual agreement and coördination necessary between all the arts and sciences in the work of the naval architect. These vessels of ours will be of 35,000 tons displacement and will be capable of a speed through the water of some 35 knots, or a little over 40 statute miles per hour. To drive this mass at this speed there will be required a machinery installation capable of delivering 180,000 horsepower. The vessels are 850 feet in length; they will carry ten high-powered 14-inch guns as a main battery, with the addition of a large number of guns of smaller caliber, to say nothing of the torpedo tubes.

Sciences Involved in Shipbuilding

Let us consider very shortly a few of the sciences involved when we undertake to build such a vessel. It is hardly necessary to say that this undertaking would not have been possible without the slow, steady development, through the ages, of the various theorems of pure mathematics, which, in their applied forms, have been necessary to material progress in the various branches of engineering. In addition to its general application, mathematics has made possible the modern systems of control of the firing of the great guns, which permit them, with a considerable degree of accuracy, to drop a shell weighing a ton, on a comparatively small target at a distance of 12 to 15 miles. This accurate control of fire is based largely on instruments or mechanisms which permit the instantaneous solution of problems containing as many as half a dozen variables.

Likewise, these ships could not be possible without the aid of astronomy, for it is through the development of that science, and through the experimental results made possible by it, that the various navigational instruments can be utilized to permit a sure and safe passage of the ship from one point of the earth's surface to another.

Chemistry has played its part, not only in its general contributions to all engineering progress, but also in its solution of specific questions and difficulties such as are involved in the manufacture of propellant powders and high explosives in forms that may be safely handled and carried on such a vessel until the selected moment for turning loose their destructive forces. Chemistry, also, through its particular manifestation in the form of metallurgy, has played one of the most important parts, by providing numerous varieties of steel, ferrous alloys and nonferrous metals, which are used in the various parts of the ship and its equipment, many of these having been developed solely for the use to which they are put in such vessels as these.

Physics, in its various branches, has played a prominent rôle. In optics it has given us the theories of and has made practicable the various instruments which, in con-

* Address delivered before Franklin Institute, Philadelphia, Pa., on May 16, when Rear Admiral Taylor was presented with the Franklin medal.

† Rear Admiral, United States Navy, Chief of Bureau of Construction and Repair.

junction with fire control systems, make possible the accurate firing of guns and torpedoes, without which such a vessel would have no *raison d'être*.

Acoustics has played its part in the solution of many particular problems and difficulties, for, in the same way that coördination has been carried out in constructing the ship, the most complete and harmonious coördination of all parts of its organization are necessary in her hour of trial by battle. This is rendered possible only by the most perfect means and instruments of communication throughout all parts of the vessel. These systems of communication must be such that they will not break down in the midst of the noises and confusion of battle, or because of the high mental tension at such times of the personnel using them.

The sciences of physiology, medicine and hygiene must likewise play their part, for, during the long years of peace each of these vessels must be the healthful and, as far as possible, the happy home for anywhere from 1,000 to 1,500 men. This means that what we term in the navy "berthing and messing" facilities, or what in civil life would be referred to as the "housing and feeding" conditions, must be based on the most modern scientific principles. Likewise, to insure efficiency in battle, the design must take careful cognizance of what these sciences have taught us as to the limitations of human endurance when working at high pressure under adverse conditions. Nor do we stop at this point, for there is provided, in addition, a completely equipped medical establishment or hospital, including operating rooms, isolation wards for contagious diseases, special examining and treatment rooms, dental facilities, etc.

Branches of Naval Architecture

Without further enumeration of the many other branches of science and engineering which necessarily enter into the design of one of these great ships, let us consider more closely the principal branches of naval architecture proper. This is, broadly speaking, the division of engineering which enables us to make use of accumulated progress and knowledge to produce one workable and efficient assembled unit in the form of a ship. Its branches closely parallel the primary operations in the design of such a ship as has been described. Given the fundamental requirements of the design, which in the naval service we term military characteristics, and which consist of a brief statement of the results which it is desired to obtain with the completed vessel in service, it is first necessary to make an estimate of the size of the ship which will permit a solution of the design problem. The first estimate or approximation must be based largely on previous practice and experience. Before the development of naval architecture, in its modern sense, the necessity usually involved rather slow, step-by-step progress from one ship to another. Naval architecture has now taught us how to make these steps much greater, so that during the last quarter of a century advances which would have been bold to rashness at an earlier time have become almost routine. The rule of step-by-step progress referred to above has at least one remarkable—we may almost say astonishing—exception. Some sixty-five years ago a famous English civil engineer and bridge builder turned to shipbuilding. Maintaining that the larger the ship the more economical and efficient her operation, Brunel attracted large capital and in association with Scott Russell, the shipbuilder and naval architect, finally produced the *Great Eastern*, which was indeed a giant by a pigmy when compared with the other iron steamships of her day. Her keel laid in 1854, launched in 1858 after many difficulties, and put in service in 1859, the *Great Eastern* was not a commercial success. She fell short of the expectations of her designers in many respects. The successful completion even in five years of such a vessel was truly a remarkable accomplishment, but her size was ahead of her day, and it was not until 1899 that we find it again reached. As already stated, progress is more rapid nowadays than heretofore, but even now naval architecture would hardly enable us to take, with confidence, such a leap as the *Great Eastern* promoters undertook.

Detail Problems

When in the early stages of a design we have, based on previous practice and experience, reached a first approximation to the size of the vessel, it is next necessary to examine in detail the problems of strength, stability, resistance and propulsion of the ship. These represent broadly the main divisions of our subject. Naval architecture, as a whole, and its branches, like engineering generally, has not yet become an exact science, and in some respects it appears impossible that this will ever be attained. The strength and stability of ships, for example, should be such as to enable them to withstand, under all conditions, the waves of the sea, but the latter are infinite in variety, and the attempt must be to provide for any manifestation arising from this variety. It is therefore not possible in a new problem to lay down an exact condition of water surface, and say that if our ship can stand this condition it can stand all others. The best we can do is to make an approximation of the most severe condition, based on previous accumulated experience and observation. There have been made many thousands of observations on sea waves, but there is yet no complete agreement in regard to their limiting characteristics, such as length, height and the relations existing between these dimensions.

About the middle of the last century Rankine gave us the first complete mathematical theory of the formation and character of waves, known as the trochoidal theory; his result had, however, been largely predicted by Grestner more than sixty years before. Although Rankine's theory does not explain and is not entirely consistent with all phenomena of this nature, it is generally accepted today as a reasonable and convenient approximation of the facts, and it is usually upon stresses due to waves such as result from Rankine's theory that we have our determinations of strength of vessels.

Strength of Ships

We find that from the very beginning of practical shipbuilding the problem of strength was recognized in concrete form, for in the very first ship of which we have historical record its picture shows what we now term a "hogging" girder, which was provided to take the strains resulting from the variation between distribution of weight and distribution of buoyancy. It was the existence of these strains and the fact that they increased with increase in length of ships that operated to limit the length, and consequently the size, of ships during the era of wooden shipbuilding, as it was then, and still is, impracticable to develop the full strength in end connections between contiguous wooden members. The introduction of iron and steel in conjunction with the development of methods and mechanisms for riveting has made the modern ships possible. For many years the provision of the necessary strength depended largely on rule-of-thumb methods and step-by-step development from one ship to another. Such methods, of course, led in the majority of cases to one of two results: either deficiency of strength or excess of strength. For any structure erected on shore the latter fault is not necessarily a serious one, except from the point

of view of cost. On a ship, however, too much material is almost as grave an error as too little, for every ship is built to perform some distinct service, and, as a floating body, can carry for all purposes only the equivalent of the weight of water which it displaces. Every pound which goes unnecessarily into the structure of the ship itself is a dead loss to the aim or object for which the vessel is designed. The modern theory of longitudinal strength for a vessel, as based on many years of observation and experiments, has its origin in the simple fundamental theories of strength of beams or girders. The ship's structure as a whole is considered as a built-up girder with upper and lower flanges and connecting webs. This girder is assumed to be supported on a wave of length equal to that of the ship. The height of this wave is assumed to have various relations to its length, depending upon the magnitude of that length, but for the majority of cases this relation is taken as one to twenty. This girder is then assumed to be supported in a manner represented by the buoyancy curve of the ship when floating on such a wave. The form of this buoyancy curve will, of course, vary with the position of the ship in relation to the crest and hollow of the wave, and in important strength calculations it is redrawn for at least two, and sometimes as many as six, positions. The loading of the girder is represented by the loading of the ship, including its own weight, that of permanent installations, such as propelling machinery, etc., and that of the variable or useful load carried. By successive integrations and the use of the simple beam formula we then arrive at the figures representing stresses and strains in the theoretical girder. Some experiments have been made from time to time, notably those of Biles in 1903, to check the accuracy of the results obtained by this method, but, due to the cost and magnitude of such experiments, there have never been collected sufficient data to enable us to say how accurately these results do represent the actual stresses in the ship in service. Accordingly, we are still largely dependent on comparing the figures obtained by this method for the new ship with those obtained by the same method for previous ships that have shown adequate strength in service.

Possibly due to the fact that our standard wave is not so steep as waves having the length of short ships, and steeper than waves having the length of long ships, it seems to have been thoroughly established by experience that, with the method outlined above, it is safe to allow larger stresses in large and long ships than in short and small ones. If, for instance, we find that by this method a small vessel in service shows satisfactory results when her figured standard stress is, say, six tons in compression and eight tons in tension, and shows indication of weakness if these figures are materially exceeded, and we would find that also in service a very large and long ship would show no signs of weakness with calculated stresses as high as ten tons in compression and twelve tons in tension. This principle appears to have been acted upon, though the scientific principles underlying it were not fully understood, even in the early days of iron shipbuilding. This was brought out about fifty years ago, when our modern methods of figuring strength were first applied to ships built in accordance with the then existing rules of the classification societies, with the result that the large ships of that day were found to have indicated stresses in extreme cases nearly five times as great as those found in small ships.

There are, of course, a very large number of strength problems involved locally in ships themselves, and therefore particularly within the province of naval architecture, but these are, after all, secondary when compared with the problem of the strength of the main structure.

Stability

Turning now to stability, which is the measure of the ability of a ship to remain upright or to return to the upright when inclined by an external force usually impressed by varying conditions of water surface, we find that the full and exact treatment of this branch is of quite modern origin. In the earliest day adequate stability was largely dependent on carrying ballast, and the amount and location of such ballast was determined by trial. In other words, except by following more or less closely the model of a previous vessel, there was no means of determining in advance whether a proposed design would result in a satisfactory stability condition.

About the middle of the eighteenth century the French mathematician Bouguer made a long step in developing the science of stability by developing the concept of the metacenter. In mathematical language, the metacenter is the center of curvature of the locus of the center of buoyancy of the vessel as it is inclined. As a practical proposition, the metacenter is the limit above which we cannot locate the center of gravity of the ship without having her initially unstable and unable to remain upright. The position in space of this imaginary point depends upon the geometrical form and the dimensions of the ship. Perhaps a homely illustration may clarify the matter. If you take an ordinary rocking chair and attach a weight to it in such a manner that the center of gravity of the chair and the weight is above the center of curvature of the rocker, the chair will not stay put and will loll and capsize. If the center of gravity is materially below the center of curvature of the rocker, which is the case when one sits in an ordinary rocking chair, the chair will remain in a fixed position; if the rocker is very flat, resulting in a greater distance of the center of gravity below the center of curvature, the chair will be stiff and harder to rock or heel from the upright position. The metacenter of a ship corresponds very closely with the center of curvature of the rocker, as already described.

After Bouguer developed the conception and mathematical methods for calculating the position of the metacenter, Atwood carried the matter further by calculating the righting arm or lever, which, multiplied by the weight involved, measures the torque when a vessel is inclined. The metacentric conception applies only to initial stability with the vessel upright, and for many years appears to have been sufficient, particularly as applied to sailing ships, which are very much of the same general type, with comparatively small variations of general form, relative freeboard, etc.

Something more than fifty years ago, however, the loss of the *Captain* brought home very strongly to naval architects, particularly in England, the fact that there was another factor involved in stability. A distinguished English officer, Captain Cowper Coles, took up with enthusiasm the monitor idea, first developed by Ericsson in this country, and as a result of his campaign there was built in England a low freeboard vessel called the *Captain*, with turrets and also full sail power. Naval architects of the English Admiralty were not enthusiastic over the type. The vessel had much less metacentric height than the pure monitor type, but early reports and experience with her indicated that she would be a great success, until on the night of September 7, 1870, in the Bay of Biscay, with a moderate gale blowing, she capsized, with a loss of 481 lives, including Captain Coles himself. The vessel was perfectly safe until conditions were such that she heeled over enough to bring her deck edge well under water.

After that her righting force rapidly decreased, and at a comparatively small heel became negative, resulting in capsizing. Under the weather conditions existing the force of the wind against the sails of the *Captain* was sufficient to heel her beyond the safety angle, and over she went.

The investigation into this disastrous occurrence brought out the fact that a vessel with a comparatively small metacentric height may be perfectly safe if it retains a righting tendency at a large angle of inclination—a feature associated primarily with high freeboard. On the other hand, a low freeboard vessel, with a comparatively short range of stability, may also be perfectly safe if its mentacentric height and initial stability are very great, so that a large amount of work has to be done to incline the vessel throughout its comparatively short range of stability.

This whole question is now fairly well understood, and the naval architect is enabled to adjust his metacentric height as he will by varying proportions and dimensions of the ship to suit the position of the center of gravity and type of vessel—all requiring very careful and detailed calculations. As a matter of fact, there are passenger vessels crossing the Atlantic in perfect safety with no initial stability, or even with a slightly negative metacentric height, their freeboard and shape giving them a range of stability of as much as 90 degrees.

Resistance and Propulsion

Since the days of Fulton's first steamboat, the design of vessels' hulls, on such lines as to give the minimum resistance in passage through the water at varying speeds, consistent with the other characteristics of the ship, has become increasingly important. This is well illustrated in the case of the new battle cruisers, to which I have already referred to. To arrive at the most advantageous dimensions and form of hull, for purposes of the high speed desired, there were made and tested in the Model Tank at Washington upwards of twenty models, with the result that the resistance of the model finally adopted was nearly 15 percent less than that of the first model tried.

I would particularly invite attention to the fact, however, that this was by no means due to improvement in shape of lines alone, but also to other changes which were adopted with some reluctance, but which it was known in advance would materially reduce the resistance. Experience in recent years has fully confirmed the conclusion drawn from Model Basin investigations that, for high-speed vessels, the length is a primary factor. In fact, we know in the majority of cases of high-speed vessels that we could reduce resistance by increasing the length. This usually involves, however, increased weight of hull and other objections. So that for large, fast vessels the naval architect usually adopts dimensions which do not give the minimum resistance for the displacement, but the best all-around result, considering the total weight, including both hull and machinery.

Men-of-war in particular are generally made relatively shorter than merchant vessels, for the reason that ordinarily they travel at a low speed, and the long vessel requires more power at low speed than the short vessel, and hence on a given endurance requires a greater weight of fuel. The merchant vessel, particularly the fast passenger vessel making its passages at top speed or thereabouts, must be economical at that speed.

A hundred years ago the ideas of ship resistance were entirely crude, the usual opinion being that the resistance was in proportion to the area of the cross-section of the vessel which had to be forced through the water. About the middle of the last century Rankine put forward a theory which went to the opposite extreme. His proposition was that in a well-formed vessel the resistance was entirely due to the friction of the surface against the water, and he developed a method for estimating this. Our modern ideas on this subject are due primarily to William Froude, the originator of modern experiments, which have been the most useful appliance of research in this line one could imagine. The "law of comparison," by which, from the resistance of a small model at low speed, we can closely estimate the resistance of a large ship at high speed, is commonly called by naval architects "Froude's Law." It appears to have been originated independently by Mr. Froude, although, as a matter of fact, it is a particular case of the general law of mechanical similitude, apparently first enunciated by Newton.

Froude's Law

The resistance of ships by the Froude methods is regarded as made up of three elements: The friction of the surface, which, for low-speed vessels, may be as much as 90 percent of the total, and seldom falls below 50 percent, even for very fast vessels; the wave-making resistance, due to the energy required to create and maintain a system of waves accompanying the motion of the ship through the water; and the eddy resistance, due mainly to eddies behind stern-posts, struts and other appendages, and hence quite a small factor in the total. The "law of comparison" applies with great accuracy to the wave-making resistance, and with reasonable accuracy to eddy resistance. To frictional resistance it is not applicable, but Mr. Froude, by experiments on surfaces, established coefficients of frictional resistance which are used to this day, although for some time naval architects have felt that it would be desirable to revise these coefficients upon the basis of experiments on a large scale. The procedure we use at the present time in obtaining the lines for a ship is about as follows:

By the use of tables and curves which have been produced as the result of years of experiment at the Washington Model Basin, certain coefficients, representing a form of underwater body, are selected, as giving a close approximation to the best solution of the particular problem in hand. By the use of these coefficients we can arrive at approximation to the best dimensions for any particular ship, and by the further use of certain standard forms of waterlines can draw, with little difficulty, the lines of the vessel. From the same data we can obtain a close approximation to the resistance, at varying speeds, of a hull built from these lines. These steps permit of settling the broad general characteristics of the design. The lines so drawn are then sent to the Model Basin, where a model to exact scale is built and its resistance accurately measured at varying speeds. In important designs, as in the case of the battle cruiser, this model will receive many variations in shape and refinements of details until it appears probable that the minimum resistance for such a hull has been reached. The resistance curve obtained from the final model is then used as the basis of the design of the machinery plant and propellers for the vessel.

There are, of course, many other divisions and subdivisions of naval architecture which enable us to foretell with a considerable degree of accuracy the behavior of a vessel under the many different conditions which may be met in a varied career of service, as, for instance, the degree of punishment which a ship can stand before sinking, when subjected to attack by gunfire, submarine torpedo, and mine and aerial bomb. These are factors which

(*Concluded on page* 495.)

Fig. 1.—S. S. *Benjamin Brewster* at the Builder's Fitting-Out Dock

Standard Oil Tanker Benjamin Brewster

Built and Engined by Harlan & Hollingsworth Corporation, Wilmington, Del., for the Standard Oil Company of New Jersey

ON February 20, the first of four large tankers which the Harlan & Hollingsworth Corporation, of Wilmington, Del., contracted to build for the Standard Oil Company of New Jersey for carrying petroleum in bulk was launched and christened *Benjamin Brewster*. This vessel has since been completed as well as a sister ship, the *W. H. Tilford*, while two other sister ships are under construction at the Harlan & Hollingsworth yards for the same owners, and also a similar vessel for the Vacuum Oil Company of New York.

The principal dimensions of the *Benjamin Brewster* are identical with those of the *Silver Shell, Gold Shell* and *Pearl Shell* recently built by the Harlan & Hollingsworth Corporation. They are as follows:

Length overall	427 feet
Length between perpendiculars	412 feet
Beam, molded	53 feet 1 inch
Beam, extreme	53 feet 5 inches
Depth, molded to second deck	24 feet
Depth, molded to upper deck	31 feet
Load draft	24 feet 8 inches
Deadweight carrying capacity	8,130 tons
Gross tonnage	5,579
Net tonnage	3,379
Speed	11 knots

The vessel has a straight stem and semi-elliptical stern with a long poop and short bridge and forecastle. She is schooner rigged with three pole masts. Propulsion is by a single screw with the machinery aft. The officers' accommodations are in houses on top of the bridge and poop, while the petty officers' and crew's quarters are in the poop and forecastle. The general arrangement of the vessel is shown on the plans, Fig. 2, Plate I, and the main scantlings of the hull on the midship section, Fig. 4.

Hull Construction

The internal subdivision of the vessel is different from that of the "Shell" boats, as the *Benjamin Brewster* has four cofferdams, while the "Shell" boats had only two. In all there are 18 transverse and 1 longitudinal bulkheads, dividing the hull into 18 main oil tanks and 10 Summer tanks. The pump room is located amidships and a cofferdam is fitted at either end of the oil cargo space. There is also an intermediate cofferdam and an additional cofferdam between the boiler room and the fuel oil bunker, making four cofferdams in all.

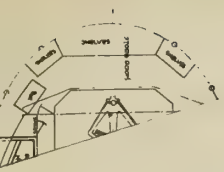
Under the forward dry cargo hold a tank is fitted for ballast or for fuel oil, if fuel oil is used in the boilers. The cross bunkers are also built oil-tight so that they may be used for fuel oil. Under the engine and boiler rooms a double bottom is fitted. The hull is built on the Isherwood system of longitudinal framing.

On an extreme draft of 24 feet 8 inches the vessel will carry 8,130 tons deadweight, the gross measurement tonnage being 5,579 tons and the net tonnage 3,379 tons. The capacity plan and deadweight scale is shown in Fig. 3, Plate II.

Machinery

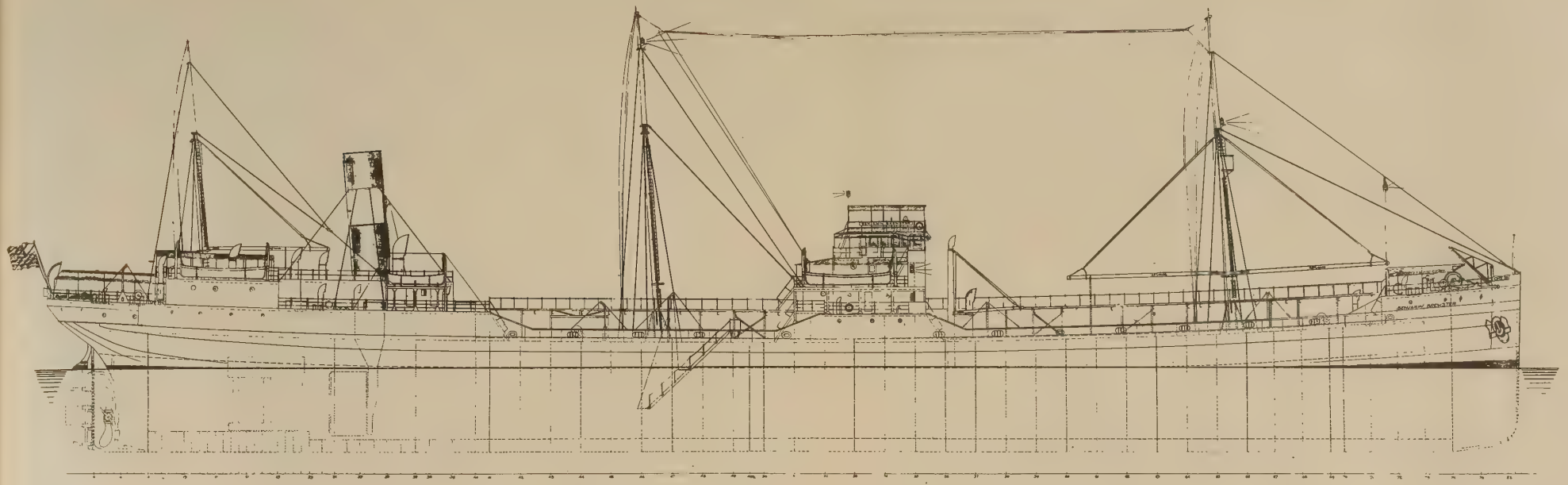
The cargo is handled by two large horizontal duplex cargo oil pumps with cylinders 15 and 11 inches diameter by 18 inches stroke, supplied by the National Transit Company. All necessary piping for handling oil or gasoline (petrol) cargo is fitted, together with heating piping, gas piping, vapor piping, etc. The vessel is fitted with an electric lighting plant located in the engine room and also an auxiliary electric generator located on the upper deck.

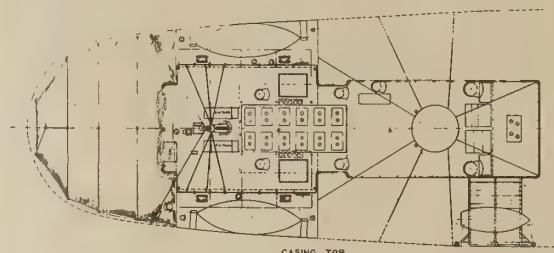
Designed for a sea speed of 11 knots, the vessel is propelled by a single screw driven by a triple expansion reciprocating engine with cylinders 27, 45 and 74 inches diameter by 48 inches stroke supplied with steam at 180

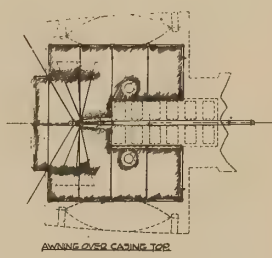


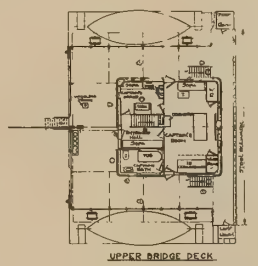
Standard Oil Tanker Benjamin Brewster

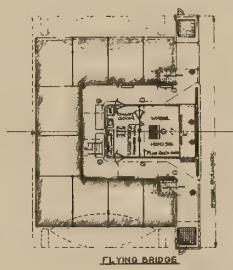
Built and Engined by Harlan Hollingsworth Corporation, Wilmington, Del.

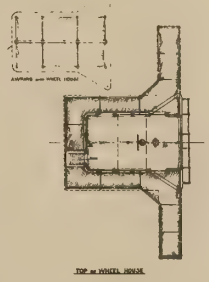


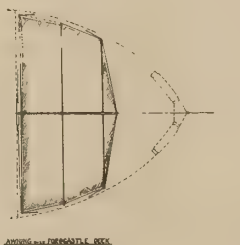


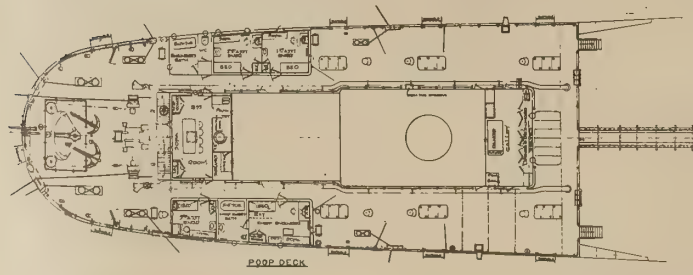


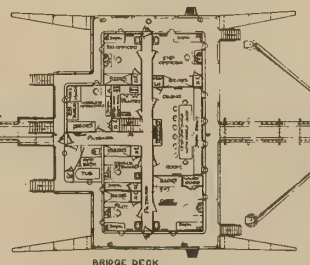


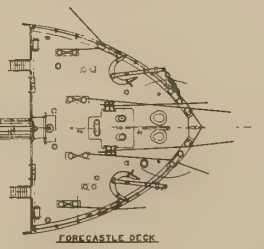


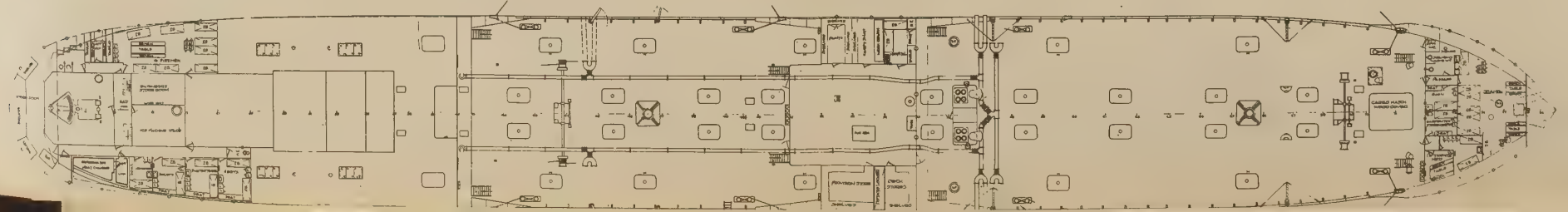


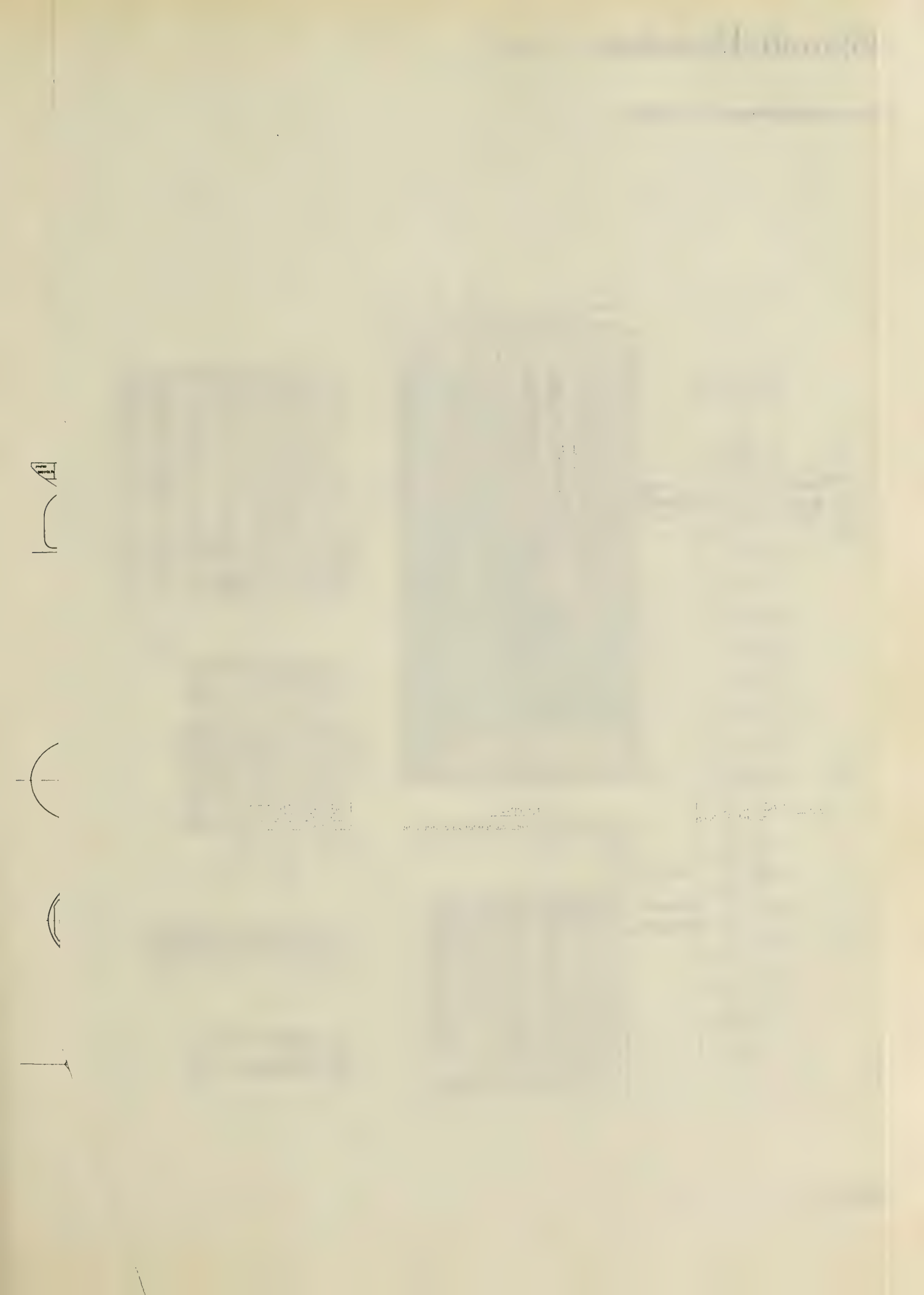






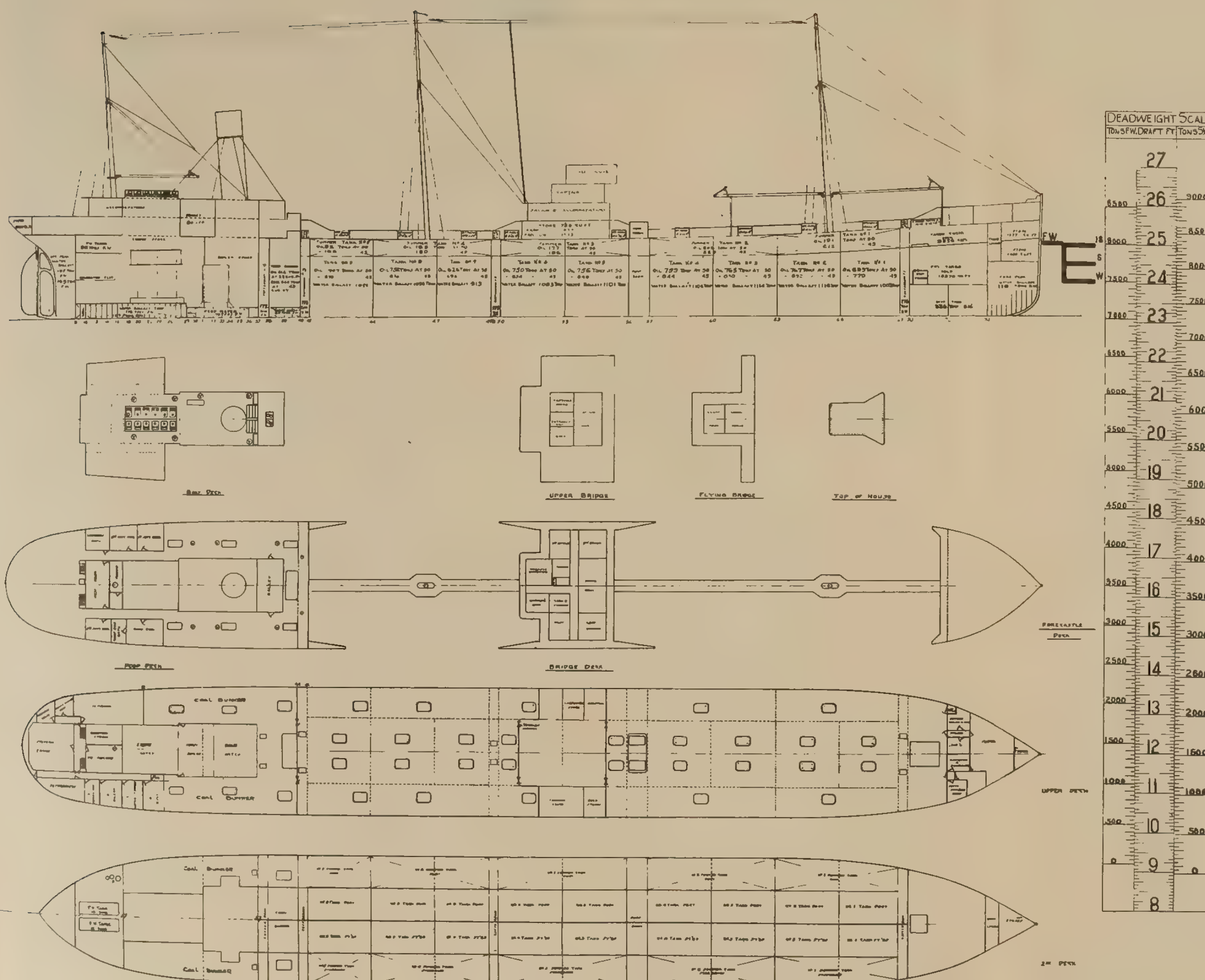






Standard Oil Tanker Benjamin Brewster

Built and Engined by Harlan Hollingsworth Corporation, Wilmington, Del.



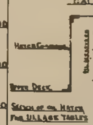
Ullage Tables for Cargo Oil Tanks

Distances Are Measured Down From Top Of Handhole Frame On Oil Hatches

Feet from Top	Tank No 9	Tank No 8	Tank No 7	Tank No 6	Tank No 5	Tank No 4	Tank No 3	Tank No 2	Tank No 1
0									
1-0									
1-6									
2-0									
2-6	396	396	396	396	396	396	396	458	748
3-0	1190	1188	[illegible]	1188	1188	1188	[illegible]	[illegible]	1178
3-6	2470	2160	[illegible]	2224	2225	2449	1728	[illegible]	2418
4-0	3810	3660	[illegible]	3480	3600	3775	3310	3170	3500
4-6	5180	5020	3445	4110	4850	5100	4800	4420	4730
5-0	6340	6200	4530	6300	6100	6425	5630	5675	5900
5-6	[illegible]	7600	5630	7510	7510	7750	6940	6925	7040
6-0	8930	[illegible]	6710	[illegible]	8850	9860	8260	8180	8200
6-6	10840	10310	7770	10130	10170	10590	9580	9415	9340
7-0	11270	11360	[illegible]	11310	[illegible]	11710	10900	10480	10510
7-6	12890	12890	[illegible]	12800	13100	13050	12200	[illegible]	[illegible]
8-0	14190	14120	11070	14100	[illegible]	14380	[illegible]	[illegible]	[illegible]
8-6	15500	15520	12110	15470	15470	15700	14830	[illegible]	13570
9-0	16810	16880	13100	16780	16730	17010	16110	15640	15050
9-6	18110	[illegible]	14590	18070	18070	18530	17480	[illegible]	15870
10-0	19460	19490	15860	19350	19350	19830	18730	[illegible]	17430
10-6	20980	21920	17300	21810	21830	21980	20020	19400	18600
11-0	22480	22410	19680	24310	24310	23100	21350	20600	19700
11-6	23760	[illegible]	21100	[illegible]	[illegible]	24700	23100	21900	20830
12-0	28460	29600	23300	27300	27500	28220	23750	23130	22800
12-6	30500	32100	26000	31000	31000	30780	28200	24700	23520
13-0	33400	34660	28200	34410	34410	33400	30000	27200	25630
13-6	35840	37150	30230	[illegible]	37010	35900	33400	29700	27800
14-0	38370	39760	32400	[illegible]	37430	38400	37830	32200	30000
14-6	40500	42270	34330	42170	42130	40900	38400	34730	32100
15-0	43300	44700	36850	44700	44700	43500	41000	37100	34800
15-6	45900	47200	38800	47200	47200	45900	43500	39750	36400
16-0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16-6	50750	56460	43100	51330	51330	51000	48500	43800	40700
17-0	53300	[illegible]	45130	54500	54500	53550	51100	47150	42600
17-6	55630	57500	47400	57400	57400	56000	53600	49700	45100
18-0	58100	60000	49500	59900	59900	58600	56800	52250	47100
18-6	60720	61600	51150	62400	62400	61800	58650	54700	49250
19-0	63100	65000	53700	64350	64350	63700	61500	57250	51300
19-6	65600	67400	55500	67300	67500	66200	63800	59000	53600
20-0	68150	70000	58000	70100	70100	68700	66200	61850	55200
20-6	70600	72600	60100	72800	72500	71300	68750	64000	57900
21-0	73100	75000	62300	75000	75100	73900	71400	67200	60000
21-6	75660	77700	64410	77600	77600	76400	73800	69700	62150
22-0	78200	80150	66000	80150	80150	78770	76100	71500	64300
22-6	80700	82500	68600	82700	82700	81500	77000	74700	66300
23-0	83010	85200	70801	85100	85100	84090	81400	77100	68400
23-6	85400	87700	71900	87100	87100	86300	84000	72700	70000
24-0	88000	90500	75610	90400	90400	89000	86500	81130	72930
24-6	90450	93100	77210	93000	93000	91400	89000	81900	75100
25-0	93100	[illegible]	79400	95300	95300	93900	91600	87300	77230
25-6	95300	97300	81200	97700	97700	96700	94000	89700	79300
26-0	97700	100400	83500	100200	100100	99100	96600	92300	81500
26-6	100300	103100	85700	103000	103000	101700	99200	94750	83400
27-0	103000	105600	87950	105500	105500	104800	101800	97050	85800
27-6	105600	108100	90000	108000	108000	106800	104300	99900	88000
28-0	108000	110600	92270	110300	110100	109300	106800	102200	90100
28-6	110400	112800	94200	113100	113100	111900	109200	104600	92300
29-0	112900	115800	96250	115700	115700	114500	111800	107200	94300
29-6	115400	118100	98100	118000	118000	117000	114200	109700	96100
30-0	118000	120500	100800	120800	120100	119300	117000	[illegible]	98400
30-6	120500	123800	103900	123100	123100	121800	119300	114000	100900
31-0	123000	126100	105000	126400	126400	125300	121900	117100	103000
31-6	125100	128200	107000	128100	128100	127000	124600	119800	105200
32-0	127800	130700	109000	130600	130600	129400	127000	122300	107200
32-6	129990	132100	111050	133000	133000	[illegible]	129900	124800	109400
33-0	132100	133800	112900	135100	135100	134100	132100	127300	111500
33-6	134400	137600	114840	137500	137600	136400	134300	129930	113800
34-0	136700	[illegible]	116300	139700	139700	138700	136800	132100	115500
34-6	138800	142000	118000	141900	141900	140800	139000	134300	118000
35-0	140500				143800	142900	141200	136700	120500
35-6							143500	139000	122700
36-0							145200	141000	124500
36-6								143000	126100
37-0								144800	127900
37-6									129500
38-0									131000
38-6									
Full	148665	145900	119200	143800	144000	146800	146000	146800	132100

~NOTE~

Capacities of cargo and fuel oil tanks are given in gallons for one side only. 7.48 gallons = 1 cu. ft.



Capacity Tables for Fuel Oil Tanks

Distances Are Measured Up From Bottom Of Tanks

Depth in Ft	Forward Deep Tank	[illegible]	No. 1 Cofferdam	Depth in Ft	[illegible]	No. 3 Cofferdam
1	2840	2295	360	21	51700	15400
2	4640	4720	974	22	54080	16210
3	7410	6960	1372	23	56480	16980
4	10480	9350	2245	24	59000	17730
5	14050	12000	3020	25	61300	18800
6	17610	14220	3800	26	63500	19500
7	21100	16700	4565	27	65600	20080
8	24800	19180	5345	28	68000	20850
9	28400	21680	6120	29	70000	21630
10	32000	24200	6900	30	70500	22400
11	35400	26720	7670	31	70900	23200
12	39000	29200	8480	32		23810
13	42700	31700	9240	33		23960
14	43100	34250	10000	34		24000
15	43400	36780	10710	35		24050
16	43500	39250	11380	36		
17	43600	41780	11710	37		
18	43750	44260	13100	38		
19	54000	46700	13850	39		
20		49350	14670	Full	71180	24070

Summary of Capacities

Cargo & Fuel Oil Tanks One Side Only					Tons of 45 Cu Ft One Side	Both Sides
Main Cargo Tanks					Main Cargo Tanks	
	Betw Frs	Cu Ft	Gallons	Barrels		
Tank No 1	66-69	17650	132100	3145	385	770
2	63-66	19550	146800	3490	436	872
3	60-63	19500	146000	3475	435	870
4	57-60	19400	145800	3465	432	864
5	53-56	19250	144000	3430	420	840
6	50-53	19150	143200	3410	417	834
7	47-49½	15950	119200	2840	348	696
8	44-47	19200	143300	3427	418	836
9	41-44	19050	142665	3395	415	830
Totals	One Side	168680	1262965	30077	3676	7352
Summer Tanks					Summer Tanks	
Tank No 1	63-69	4860	36400	867	106	212
2	57-63	5140	38450	916	114	228
3	50-56	4300	33700	802	98	196
4	44-49½	4150	31050	739	90	180
④ 5	41-44	2353	17600	418	51	102
Totals	One Side	21000	157200	3742	459	918
Compartments Used Only For Oil Fuel					Oil Fuel	
⑤ Deep Tank	70-74	5880	43985	1047	128	256
① Cross Bunker	38-40	9500	71180	1695	207	414
③ Cofferdam	40-41	3214	24070	573	70	140
④ Summer Tank 5	41-44	2350	17600	418	51	102
Totals	One Side	20944	156835	3733	456	912

~NOTE~

In the table above 2% has been allowed for expansion in the last two columns only.

Coal Bunkers Both Sides			
Compartment	Betw Frs	Cu Ft	Tons
Betw Pet & Upper Pl	17-37	11172	279
Upper & Poop Pl	21-40	14935	356
① Cross Bunker	38-40	18460	440
Totals		44567	1075

Water Tanks Both Sides				
Compartment	Betw Frs	Cu Ft	Tons F.W.	Tons S.W.
Fore Peak	74 Stem	3874	110	107
⑤ Deep Tank	70-74	11760	336	326
② Cofferdam #1	69-70	6060	176	168
③ Cofferdam #2	49½-50	6460	184	178
②③④ Cofferdam #3	40-41	6400	182	178
Water Ballast	38-40	1950	55	54
Cofferdam #4	37-38	6240	178	172
Feed Water	30-37	2820	80	78
Water Ballast	11-29	3880	110	107
Aft Peak	0-8	3700	105	103
Fresh Water Tanks	8-17	1296		36
Totals		54440	1516	1507

① Available For Oil Fuel or Coal
② " " " " Ballast
③ " " Cargo Oil "
④ " " " Oil Fuel
⑤ " " Oil Fuel - Fresh Water

Cargo Holds Both Sides			
Space	Betw Frs	Cu Ft Grain	Cu Ft Bales
Deep Tank Top To 2nd Deck	70-74	12370	11725
Second Deck To Upper Deck	70-74	9856	9514
Totals		22226	21239

Principal Dimensions

Length Overall	427-0
Length Lloyds	412-0
Beam Molded	53-1
Depth Molded To Second Deck	24-0
Depth Molded To Upper Deck	31-0

Fig. 3-Capacity Plan and Deadweight Scale

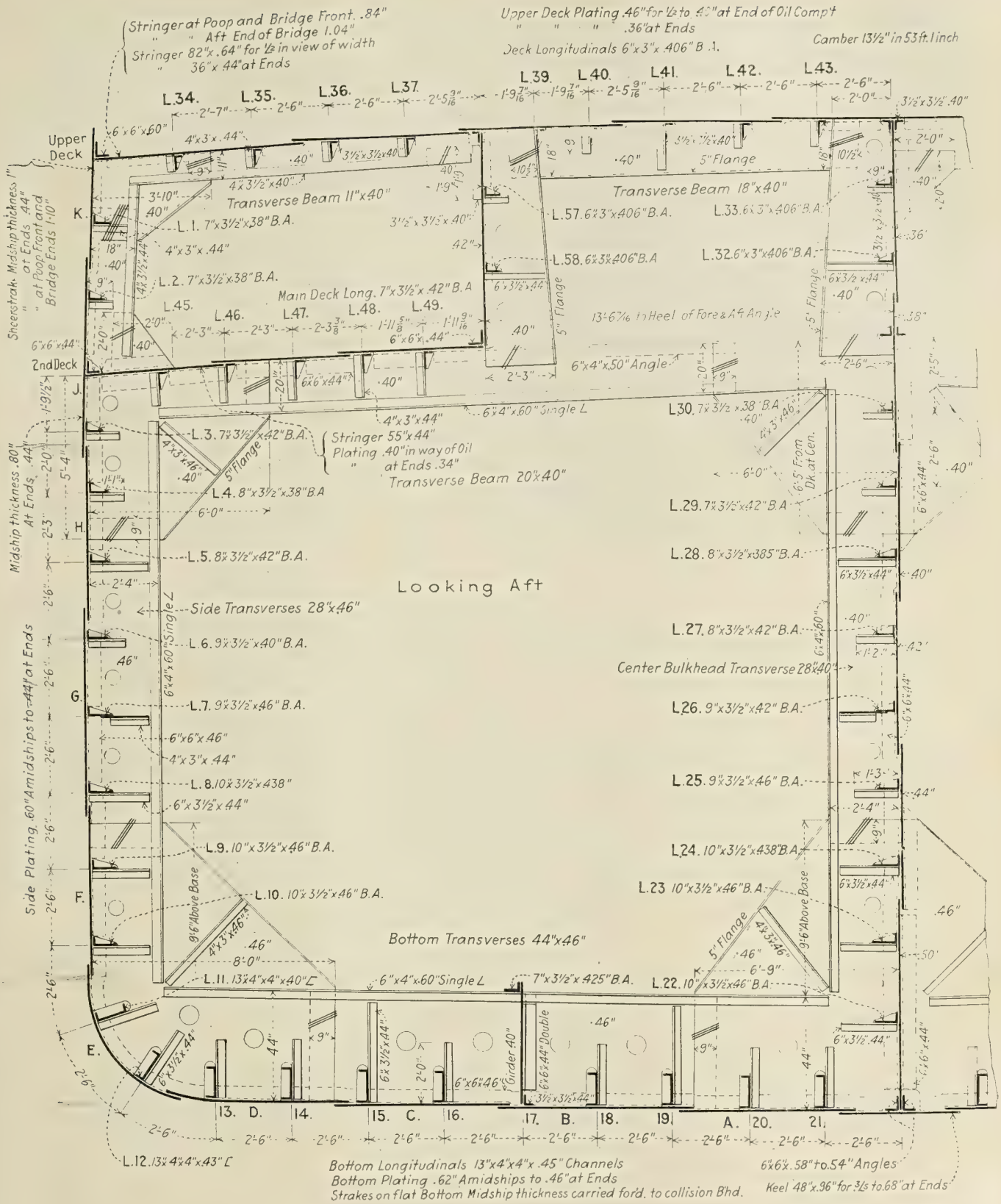


Fig. 4.—Midship Section, S. S. *Benjamin Brewster*

pounds per square inch working pressure from three marine type Scotch boilers, each 15 feet 6 inches diameter by 11 feet 7 inches long. The boilers have a total heating surface of 8,300 square feet and are arranged for burning oil or coal as fuel, under the Howden system of hot air forced draft.

The vessel is equipped with wireless apparatus, fire-fighting, life-saving, signaling and navigating appliances, as required by the United States Steamboat Inspection Service. The officers' and crew's accommodations are very commodious and well appointed, fully equipped to pass the United States Steamboat Inspection requirements.

The hull and machinery throughout is built to the highest class at Lloyd's under special survey by Mr. J. S. But-

Fig. 5.—Launching of S. S. *Benjamin Brewster* at Yards of Harlan & Hollingsworth Corporation, Wilmington, Del., on February 20

ler and Mr. J. Blellock, Lloyd's surveyors. For the above particulars and plans of the vessel we are indebted to Mr. R. W. Bruce, naval architect, of the Harlan & Hollingsworth Corporation.

Regulations for the Protection of Ships in Danger Zones

The United States Shipping Board has issued a set of rules, based upon a consideration of the facts relating to the sinking by mines or submarines of a large number of vessels, which are recommended for adoption by the owners and masters of ships in service in danger zones. Copies of these rules will be furnished free of charge by the Shipping Board.

Experience has shown that vessels holed by mines or torpedoes sink so rapidly as not to permit the taking of corrective measures. Open watertight doors, side scuttles and other apertures in hulls have caused the loss of ships which otherwise, perhaps, might have been kept afloat. Lives have been lost as a result of the failure in anticipation of disaster to provide for an expeditious transfer to boats and rafts of passengers, officers and crews.

Every precaution, therefore, should be taken in advance of entering a danger zone to minimize the risk of mines and submarines, and the promulgation by owners and masters of the regulations suggested by the Shipping Board, it is believed, will contribute materially to that end.

The printed regulations cover only twelve pages of a pocket-size pamphlet, and, therefore, can be quickly and easily assimilated. They refer specifically to the maintaining in efficient condition at all times of watertight bulkheads, tunnels and doors, the closing of openings in ships' sides, care of bilge pumps, stowing of cargoes, emergency lighting of ships, berthing of passengers, means of reducing the visibility of vessels and the handling of lifeboats and other life-saving appliances.

It is of first importance, of course, that doors in watertight bulkheads should be constantly inspected and kept in perfect working order. Watertight doors should be leaving stokeholds by means of the fiddley ladders. Where opened at sea only when absolutely necessary. The watertight doors in passageways from firemen's quarters to stokeholds should be kept closed, the firemen entering and practicable, it is recommended that watertight trunks should be fitted from bulkhead decks to shaft tunnels, and tunnel doors should be kept closed. If there are side bunkers, or bunkers the doors to which are in non-watertight bulkheads, coal should be worked from such bunkers while in danger zones and doors to watertight bulkheads should be kept closed.

With the exception of ash chutes and similar apertures required to be opened at sea, side scuttles and other openings in ships' sides below the uppermost continuous deck and in the first tier of erections above that deck should be kept closed while the vessel is in a danger zone.

Bilge pumping installations should be maintained at all times in an efficient condition. Before the commencement of each voyage bilges and strum boxes in holds and machinery compartments should be cleaned and defects in the system should be corrected. If practicable an additional screw-down non-return valve should be fitted in each pipe line on the watertight bulkheads inside compartments in which strum boxes are located and valves should be secured by studs screwed into bulkheads.

The fate of the men below decks in the recent *Antilles* disaster eloquently emphasizes the importance of the recommendations as to the berthing of passengers, which provide, that while traversing a danger zone passengers should be berthed above the uppermost continuous deck and watertight doors and scuttles in passengers' quarters below that deck, as well as sanitary discharges connected with such quarters, should be kept closed.

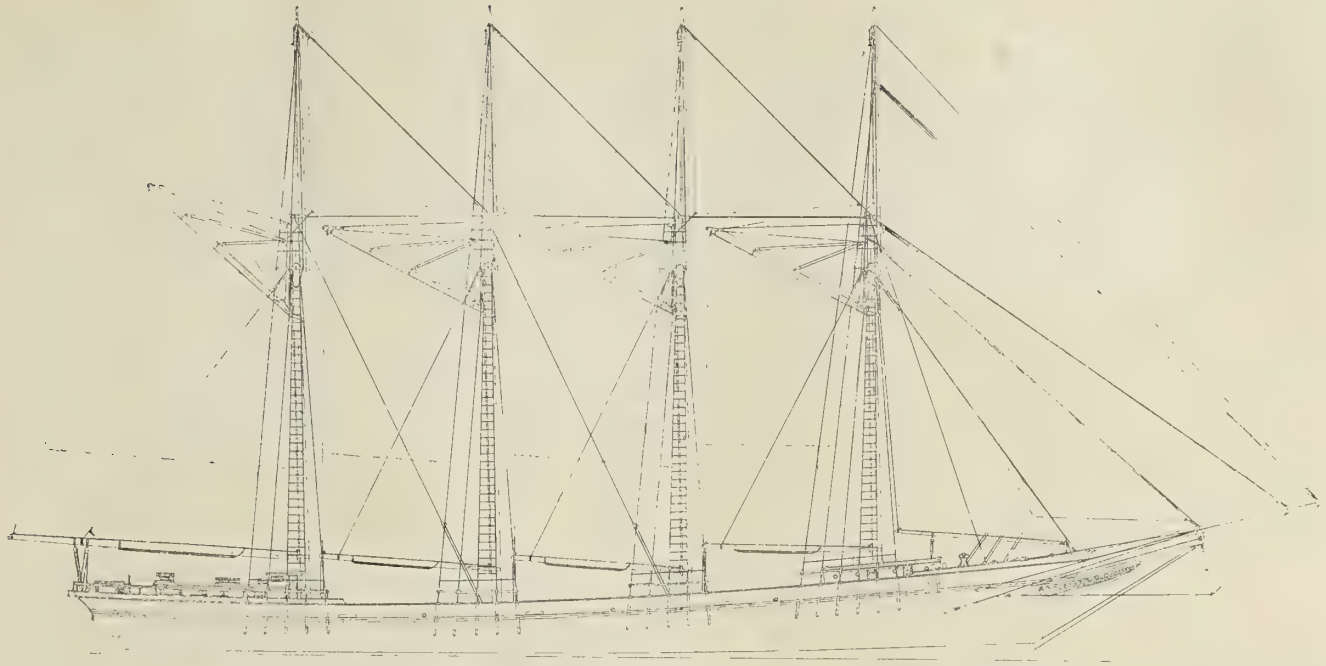


Fig. 1.—Sail Plan of Four-Masted Anxiliary Wooden Schooner Building in New Brunswick

Auxiliary Schooners Building in New Brunswick

TWO 185-foot auxiliary four-masted schooners are now building by D. H. Saker & Co., St. John, N. B., from designs by J. Murray Watts, naval architect, Philadelphia, Pa. The first of these boats is in frame, and the keel of a duplicate will shortly be laid. The general dimensions are: Length over all, 185 feet; length on keel, 160 feet; beam extreme, 40 feet; depth of hold, 14 feet; molded depth, 15 feet 8 inches.

The vessels are constructed to the latest requirements of Lloyds and the American Bureau of Shipping, and utilize as far as possibe the timber available in New Brunswick. The keel is of birch 14 inches by 20 inches, with a 4-inch birch shoe. The timbers are birch below the waterline and black spruce above, sided 11 inches double, molded 14 inches and spaced 27 inches. The keelson consists of three tiers of 14-inch by 14-inch British Columbia fir, and the sister keelsons of two tiers on each side of 14-inch by 14-inch British Columbia fir. The deck beams are also 14-inch by 14-inch British Columbia fir, spaced 3 feet 6 inches apart.

The planking varies from 7 inches to 4 inches in thickness; the under-water portion being birch and the topsides being 4½-inch black spruce. The decking is of 3½-inch spruce. Practically all the deck joiner work, houses and hatches will also be of spruce. The masts, however, will be of Oregon pine, the foremast being 25 inches in diameter and the other three masts 24 inches in diameter; all 84 feet in length. The topmasts are 48 feet 6 inches long and will be of spruce, as will be the other spars, with the exception of bowsprit, jib boom and spanker boom, which will be of Oregon pine.

The engine for one of the boats will be a 250-horsepower Kahlenberg oil engine, while the engine for the second schooner has not yet been decided on.

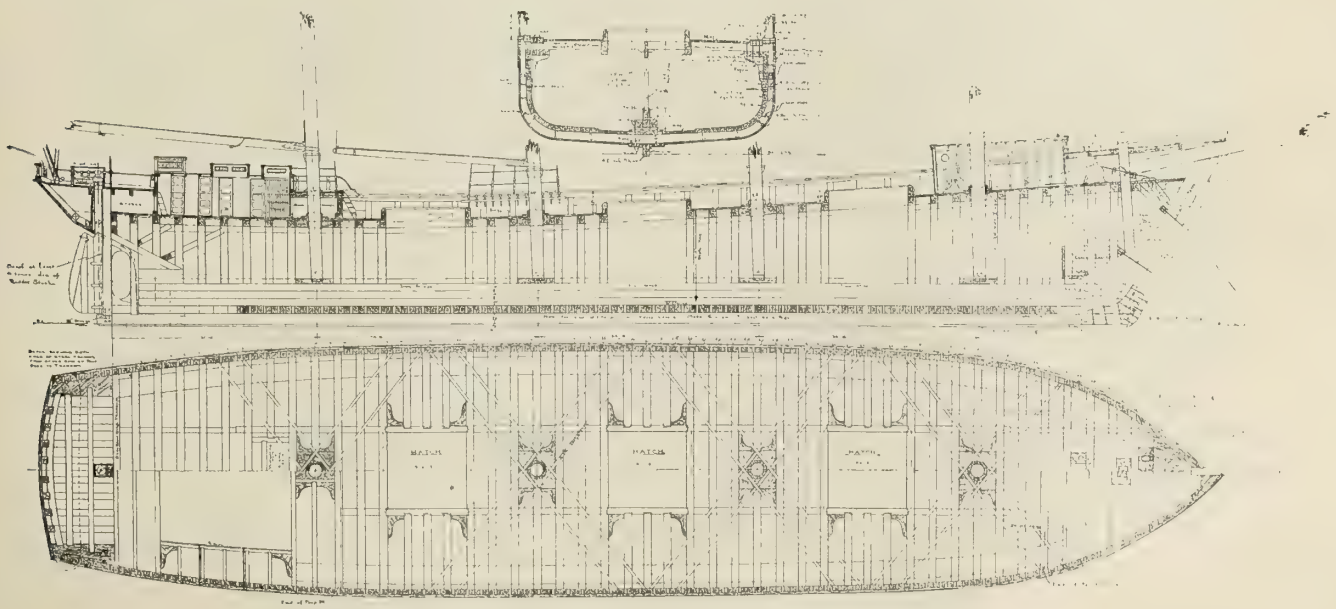


Fig. 2.—Inboard Profile, Deck Plan and Midship Section

GIANT CRANE FOR UNITED STATES NAVY YARD

Built by Wellman-Seaver-Morgan Company, Cleveland, Ohio

Fig. 1.—Crane Completed and Ready for Test at Norfolk Navy Yard

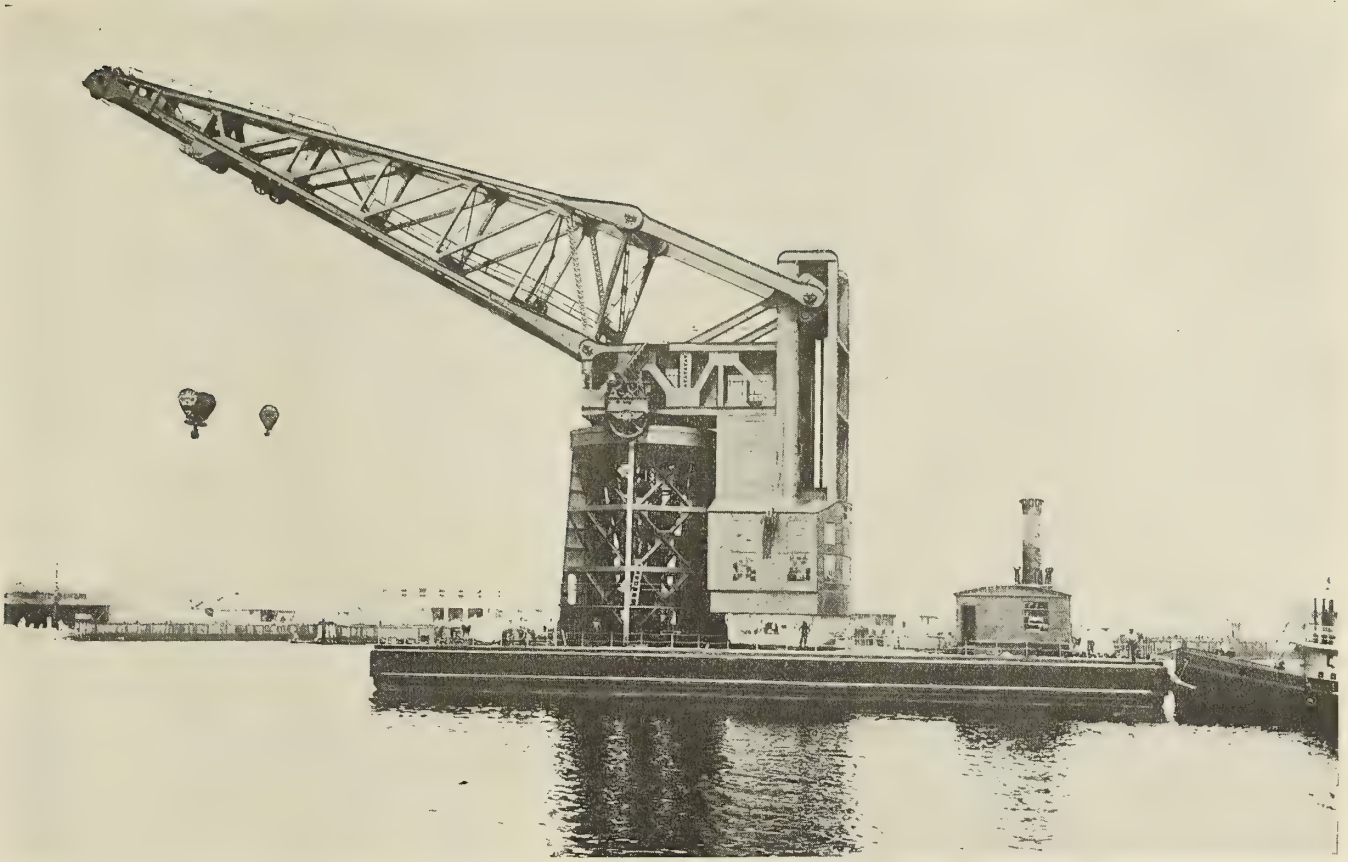


Fig. 2.—Broadside View of Crane, Tower and Pontoon with Power Plant

Giant Crane for United States Navy

Two Hundred-Ton Floating Crane Built by Wellman-Seaver-Morgan Company, Cleveland, for Norfolk Navy Yard

THE largest floating crane ever constructed in the United States has recently been designed and built by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, for the United States Navy. It is now being used by the Navy Department at the Norfolk Navy Yard.

This crane is mounted on a pontoon 140 feet long, 85 feet wide and 15 feet deep. It has a lifting capacity of over 200 tons. The test load required by the Navy for this machine, which it has already successfully handled, was 403,200 pounds, at a reach of 62 feet 6 inches over the side of the boat, or at a radius of 105 feet.

The builders of this crane have in the past few years successfully entered a field formerly monopolized by two or three European firms. This firm has also built three other large floating cranes for the Navy, but none as large as this. The previously built cranes have been of the bridge type, in which the whole crane with its pontoon are turned and maneuvered to bring the hoisting cables to the proper positions for lifting loads.

The machine just completed, however, resembles somewhat in principle the ordinary revolving derrick, in which the jib is rotated until it comes opposite the work to be lifted and is then lowered until the hooks hang above the object to be lifted. The hooks are then lowered or raised by means of steel cables passing over sheaves built into the end of the jib.

To give a more concrete idea of the size and capacity of this apparatus, it may be said that its full-load capacity is equivalent to the weight of 100 of the largest touring cars. The crane would readily lift an ordinary shifting locomotive. The main hoist consists of two hooks, weighing 75 tons each, fixed on the jib. When raised to its maximum height the top of the jib is over 200 feet above the water level; a height greater than that of an 18-story building. It must also be remembered that the whole structure is mounted on a floating pontoon, the stability of which must not be endangered by handling these immense loads. The total displacement of the pontoon crane is 5,000,000 pounds.

The pontoon itself contains a complete boiler plant and 150 kilowatt, engine-driven generator, which supplies the electric current for operating the various motions of the crane, which are controlled from a small house mounted high above the deck. One operator, by means of a few levers and master controllers (similar to those used in a passenger elevator), is able to control all the functions with the utmost delicacy.

The electrical mechanism is such that when the heavy loads are lowered the motors are turned into generators in such a way that the speed can be controlled with great nicety. In case of an accidental interruption of electric current, all motions of the crane are automatically locked by means of magnetic brakes, so that it is impossible to drop the load from such a cause. Great safety and accu-

racy of control are essential, as the crane is used to handle large guns and turrets on battleships. These must not be damaged, their value being hundreds of thousands of dollars.

Fig. 3 shows the first work which this crane was called upon to do. The Navy tug *Massasoit* was suddenly sunk in one of the harbors. After divers had passed cables under the tug, they were attached to the crane and the tug was readily and quickly lifted to the surface, as shown.

It will be recalled that the Panama Canal Commission purchased two large cranes of this type for heavy lifting

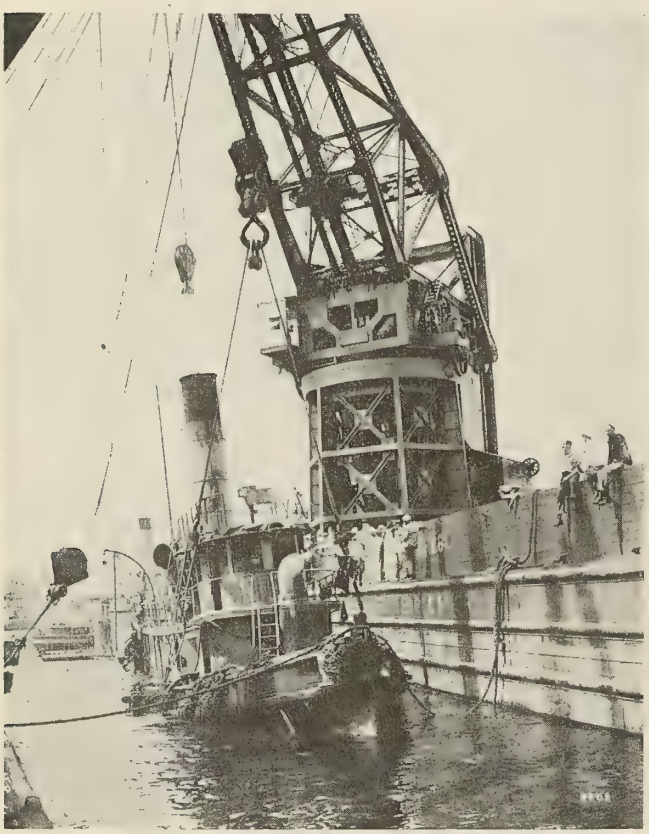


Fig. 3.—Floating Crane Hoisting Sunken Tug

work at Panama. These cranes were bought from a large German corporation. When the test load was applied (which was the same as was applied to the machine shown in the illustration) the first of these German-built cranes collapsed and was wrecked, owing to the faulty design of the structure. In comparison, no weaknesses whatever have developed in any of the floating cranes built by the Cleveland concern.

The crane rotates in a complete circle, the rotating being controlled by two 60 horsepower motors. The boom luffs up and down from a practically vertical position to an angle of about 30 degrees in the horizontal, in its lowest position. The luffing is accomplished by two 10-inch screws operated by two 60 horsepower motors.

The two main hoists can operate separately or simultaneously, as desired. When lifting the maximum load it is operated by two 60 horsepower motors. An auxiliary hoist of 25 tons capacity, movable up and down the boom, has a separate motor for hoisting and trolleying, each of which is 60 horsepower.

The counterbalance at the aft end of the crane is fixed and amounts to 600,000 pounds.

The crane is provided with four electrically-driven capstans, one at each corner of pontoon. There are also two steam-driven anchor hoists, one at each end.

The main pivotal bearing, or step bearing, supports a ball or universal joint and carries a maximum load of 2,021,000 pounds.

The speed of the main hoist under maximum load is about 6 feet per minute. The speed of the auxiliary hoist is 30 feet per minute. The speed of rotation is one revolution in four minutes. The boom is luffed from one to the other extreme position in twelve minutes. During the test all the speeds of this crane were in excess of those required by the specifications. The side lists and end lists were both under specified limits, the maximum side lists having been specified at 6 degrees.

The design was carefully worked out and it has not been found necessary to make any changes in a second machine now being built. About 5,000 tons of steel were required to build the superstructure including the crane and its tower.

Programme of Annual Meeting of Society of Naval Architects and Marine Engineers

The twenty-fifth general meeting of The Society of Naval Architects and Marine Engineers will be held in Assembly Room No. 1, Engineering Societies Building, 29 West Thirty-ninth street, New York City, Thursday and Friday, November 15 and 16, 1917, and will begin at 10 A. M. each day. The society's office will be open for the use of all members, and the usual conveniences provided.

There will be a banquet in the Grand Ball Room of the Waldorf-Astoria at 7 P. M., Friday, November 16, to which all members and their guests are cordially invited.

The Council will meet at 3 P. M., Wednesday, November 14, in the Council Room, Engineering Societies Building. Applications for membership should be mailed so as to reach the secretary on or before November 14.

The preliminary program of papers to be read at the meetings is as follows:

THURSDAY, NOVEMBER 15

1. "Safety of Life and Property at Sea, with Studies Relative to the Possibility of Rendering Ships and Merchandise Unsinkable." By William T. Donnelly.
2. "Shipbuilding in the Gulf States and the Natural Resources and Facilities Favorable Thereto." By Charles N. Crowell.
3. "Progress of Marine Engineering and the Education of the Marine Engineer." By Robert Haig.
4. "Wind and Fouling Resistance on the *Neptune*." By W. W. Smith.
5. "Cargo Ship Lines of Simple Form." By Naval Constructor Wm. McEntee, U. S. N.
6. "Recent Developments in Tank Steamer Construction." By Robert W. Morrell.
7. "Power and Economy Tests of the S. S. *Pontiac*." By A. G. Mattsson and Thomas Durkin.

FRIDAY, NOVEMBER 16

8. "Labor and Patriotism." By Asst. Naval Constructor A. W. Carmichael, U. S. N.
9. "Application of Electricity to Various Auxiliaries on Shipboard." By H. L. Hibbard.
10. "Submarine Hulls—Comments on Various Types." By Naval Constructor E. S. Land, U. S. N.
11. "The Influence of the War on Submarine Policy." By Marley F. Hay.
12. "An Analysis of the Principles of Industrial Management." By Naval Constructor T. G. Roberts, U. S. N.
13. "Fabricated Ships." By R. H. M. Robinson.

The Trend in Marine Engineering*

Turbine Development and Adoption of Speed Reduction Gearing—Progress of Watertube Boilers and Superheaters

BY C. R. BRUCE

TAKING the period up to the declaration of war, the quadruple expansion engine had to a very considerable extent superseded the triple expansion type for ships intended to make long voyages, and more especially for passenger liners in which a four crank engine had to be fitted on account of high power and greater smoothness of running. For cargo steamers, even of large size, however, the majority of owners still pinned their faith to the three cylinder engine, the argument being that any gain in fuel economy due to the quadruple principle was neutralized by the loss of cargo space, and increased first cost, weight and upkeep.

It is further to be observed that when superheaters are fitted, triple expansion engines are as economical as quadruple engines with saturated steam. The practice of superheat has greatly extended in recent years. At the present time there are about 1,000 merchant vessels, representing close on 2,000,000 horsepower, fitted with superheaters of the smoke-tube type. Independently oil-fired superheaters have been suggested as an alternative, and there are two owners at least who are giving the question serious consideration for vessels now under construction on the Clyde.

Direct-Acting Turbines

Turning to the faster vessels associated with the passenger service, the reciprocating engine appears in a new light. It was in the cross-channel passenger service that the inherent limitations of the reciprocating engine first became apparent. In the later nineties, with the higher powers of cross-channel steamers and the lightness demanded, a point was reached beyond which further development of the reciprocating engine could not be hoped for. In the meantime a significant departure was made in the Navy, when the destroyers *Viper* and *Cobra* were ordered in 1898 and fitted with Parsons turbines. The promising performances of these pioneers led in 1901 to the building of the turbine steamer *King Edward,* which was followed by the cross-channel steamer *Queen* in 1902, and the *Brighton* in 1903; and it is common knowledge that the success of these vessels led to the wholesale adoption of the steam turbine for cross-channel service. Thus the introduction of the steam turbine proved opportune by opening up a way to further progress in economy, combined with lightness, far beyond the possibilities of the reciprocating engine.

The turbine was now fairly established in the cross-channel service, but the reciprocating engine was still supreme in the field of the large liner. It was not until 1905 that the turbine entered the lists in the transatlantic service, when the *Victorian* and *Virginian* of the Allan Line took up their stations, to be followed later in the same year by the Cunard liner *Carmania.* The results on service of this latter vessel did not warrant the adoption of direct acting turbines to drive a ship of this type at a speed of 18 knots, for it was found that the coal consumption of the *Carmania* was considerably greater than that of her sister ship, the *Caronia,* with quadruple expansion engines. The performances of the *Carmania* did not, however, interfere with the employment of turbines for liners of relatively high speeds, and direct acting turbines were fitted from this time onwards to many first class liners, such as the *Lusitania, Mauretania, Aquitania, Imperator, Alsatian, Calgarian,* etc.

The Combination System

The higher consumption of the *Carmania* as compared with that of the sister ship was a setback to the direct turbine for moderate speeds. This bid fair to interfere with the natural development of the intermediate liner, for which greater powers were being demanded day by day. In 1901, however, an interesting experiment had been tried in the destroyer *Velox,* which was fitted for cruising speeds with a combination system of machinery in which the reciprocating engines exhausted into ordinary Parsons low pressure turbines, showing by this means a notable reduction in steam consumption.

In 1908 the "combination system," as this arrangement came to be termed, was tried in the *Otaki* for the main engines. In comparison with the *Orari* and *Opawa,* which were sister ships having triple expansion engines, the *Otaki* gave an economy in steam consumption of about 20 percent. The arrangement, however, was essentially one to be associated with vessels of relatively high power and the largest dimensions, and the comparative popularity of the combination system may be gathered from the statement that, taking ocean liners of over 3,000 tons register, there are some 28 driven by direct turbines and 24 by combination machinery.

While the combination arrangement of machinery undoubtedly supplied a notable link in the development of marine propulsion, it could not be looked upon at best as anything but a makeshift, and when the combination system seemed most firmly established ingenious minds were at work with the object of eliminating the weak partner—that is, the reciprocating element. Investigation proved that the turbines of the *Carmania* ran too slowly and the propellers too fast, and it became obvious that a link would require to be introduced which would enable a maximum overall propulsive efficiency to be obtained. Various expedients were proposed with this object in view, of which mechanical gearing is the simplest and most widely adopted.

Turbines and Mechanical Gearing

The application of Parsons turbines and mechanical gearing in the single screw steamer *Vespasian* in 1910 is a matter of history. In 1911 the cross-channel steamers *Normannia* and *Hantonia* were fitted with mechanical gearing, to be followed in 1913 by the *Paris* and *King Orry.*

For ocean-going steamers, however, owners still fought shy of the new arrangement, and it said much for the foresight and enterprise of the Cunard Company that they decided in 1913 to adopt geared turbines for their twin screw steamer *Transylvania,* which was then in course of construction at Greenock. This vessel was the first ocean-going liner to be so fitted. The *Transylvania* had single reduction gear, in which the reduction of propeller revolutions was obtained in a single stage. When turbines

* From a paper presented before the Greenock Association of Engineers and Shipbuilders.

TABLE I.—PROGRESS IN MARINE MACHINERY, CARGO STEAMERS.

Year when built.	1877.	1885.	1911.	1914.	1916.
Ship Dimensions:					
Length and Beam	314′ x 35′	320′ x 38′	440′ x 52′6″	450′ x 56′	503′ x 63′
Performance:					
Speed in knots	11.25	12.25	13.25	14.25	14.25
Horsepower	775 I.H.P.	1,650 I.H.P.	4,200 I.H.P.	6,000 S.H.P.	7,000 S.H.P.
Engines:					
No. of Propellers	One.	One.	One.	One.	Two.
Type of Machinery	Tandem compound with fly wheel.	Triple-expansion.	Triple-expansion.	Parsons' geared turbines, single-reduction, one h.p. and one l.p.	Brown-Curtis turbines and double-reduction gear, two h.p. and two l.p.
Propeller R.P.M.	52	70	73	102	80
Piston Speed—feet per min	450	560	750	1,350 revs. of turbines.	H.p. turbines 3,500 revs.; L.p. turbines, 2,500 revs.
Referred Mean Press	23	31.5	35	....	....
Condenser Surface per Horsepower	2.17	1.83	1.50	1.18	1.12
Boilers:					
No. and type	One, oval ends and round middle portion.	Two, cylindrical, single-ended.	Two, main cylindrical, double-ended.	Two, cylindrical, double-ended.	Three, cyl. oil-fired boilers (with Robinson superheaters), D.-E.
Working Pressure, square inch	70 lb.	150 lb.	190 lb.	195 lb.	200 lb.
System of Draft	Natural.	Natural.	Forced Draft.	Howden's Forced Draft.	Wallsend Howden oil-burning.
Heating Surface per Horsepower, square feet	4.46	2.82	2.80	2.30	2.25
Horsepower per square foot of grate	7.6	10.4	16.25	20.0	....
Weights:					
Total weight of machinery steam up	200 tons.	340 tons.	900 tons.	930 tons.	1,100 tons
Horsepower per ton of machinery	3.87	4.85	4.67	6.45	6.35
Fuel Consumption:					
Per horsepower	About 2.5 lb.	1.95 lb.	1.65 lb.	1.45 lb.	0.85 lb.

TABLE II.—PROGRESS IN MARINE MACHINERY, CROSS-CHANNEL STEAMERS.

Year when built.	1890.	1898.	1904.	1910.	1916.
Ship Dimensions:					
Length and Beam	300′ x 34′ 6″	315′ x 37′	330′ x 42′	316′ x 41′	302′ x 35′ 6″
Performance:					
Speed in knots	18	19.75	19.5	21.5	23.5
Horsepower	4,400 I.H.P.	5,520 I.H.P.	5,500 S.H.P.	8,500 S.H.P.	12,300 S.H.P.
Engines:					
No. of Propellers	Two.	Two.	Three.	Three.	Two.
Type of Machinery	3-cyl. Triple-expansion.	4-cyl. Triple-expansion.	Parsons' direct turbines, one h.p. and two l.p.	Parsons' direct turbines, one h.p. and two l.p.	Parsons' geared turbines, two h.p. and two l.p.
Propeller R.P.M.	130	165	550	625	435
Piston Speed—feet per min	780	910	550 revs. of turbines.	625 revs. of turbines.	H.p. turbines, 2,600; L.p. turbines, 1,800.
Referred Mean Press	30.75	43.0	....	....	....
Condenser Surface per Horsepower	1.42	1.4	1.35	0.75	0.6
Boilers:					
No. and Type	Five S.E. cyl.	Four S.E. cyl.	Two D.E. and one S.E.	Seven water-tube.	Eight Water-tube.
Working Pressure, square inch	160 lb.	180 lb.	150 lb.	190 lb.	195 lb.
System of Draft	Natural.	Forced.	Forced.	Forced.	Forced.
Heating Surface per Horsepower, square feet	2.6	1.95	1.9	1.95	2.0
Horsepower per square foot of grate	12.25	17.5	16.5	15.0	22.0
Weights:					
Total weight of machinery, steam up	590 tons.	610 tons.	590 tons.	735 tons.	1,055 tons.
Horsepower per ton of machinery	7.45	9.02	9.3	11.6	11.65
Fuel Consumption:					
Per horsepower	2.25 lb.	2.1 lb.	1.8 lb.	1.7 lb.	1.5 lb.

requiring a reduction of 5 to 9 are fitted, it will usually be found that they may be designed to run as fast as their construction will permit, and in this class are included all high-speed vessels.

With the larger reduction ratios, however, it will often be advisable and necessary to effect the reduction in two stages, by the adoption of what is known as double reduction gear. With this arrangement the pinion on each turbine drives a first reduction wheel, the spindle of which is provided with a further pinion, gearing into a second reduction wheel keyed to the propeller shaft.

The following advantages have been claimed for an arrangement of turbines and gearing on this principle:

1. Increased range of reduction.
2. The turbines are much smaller in diameter.
3. The gear wheels are considerably reduced in size, while the pinions are increased, giving a much better tooth contact.

Whether mechanical gearing will fulfill all expectations remains to be seen. According to present indications, it would seem that the advent of the geared turbine means that the reciprocating engine is doomed for powers above, say 3,000 horsepower for single screw and 6,000 horsepower for twin screw ships.

STEAM BOILERS

As regards steam generating, while the cylindrical boiler has remained almost unchanged in general design and construction during the last twenty years and more, the watertube boiler has made great progress in the same period. Among the lighter classes of naval vessels great power is demanded on the lightest possible weight, and, as might be expected, it is in this sphere that the marine watertube boiler made its first appearance in 1893 or thereabouts. In the merchant service shipowners adopted a conservative attitude towards the new boiler, though in

TABLE III.—Progress in Marine Machinery, Intermediate Ocean Liners.

Year when built.	1880.	1892.	1911.	1914.	1916.
Ship Dimensions:					
Length and Beam	400′ x 45′	470′ x 53′	520′ x 64′	550′ x 65 6″	550′ x 66′
Performance:					
Speed in knots	12.5	12.5	14.5	16.5	17.0
Horsepower	3,000 I.H.P.	3,500 I.H.P.	7,500 I.H.P.	11,000 S.H.P.	11,000 S.H.P
Engines:					
No. of Propellers	One.	Two.	Two.	Two.	Two.
Type of Machinery	Vertical compound.	Vertical triple-expansion.	Vertical quadruple-expansion.	Parsons' geared turbines, two h.p. and two l.p., with helical gearing.	Brown-Curtis geared turbines, two h.p. and two lp., with double-reduction gear.
Propeller R. P. M.	61	80	82	133	85
Piston Speed—feet per min.	671	640	738	1,650 revs. of turbines.	H.p. turbines, 3,200; L.p. turbines, 2,000.
Referred Mean Pressure	20.5	32.0	37.0	....	....
Condenser Surface per Horsepower	1.85	1.60	0.84	0.80	0.62
Boilers:					
No. and type	Two cylindrical.	Two D.E. and one S.E. cyl.	Five D.E. cyl.	Five D.E. cyl.	Five Yarrow, burning oil.
Working Pressure, square inch	90 lb.	170 lb.	210 lb.	210 lb.	250 lb.
System of Draft	Natural.	Natural.	Natural.	Howden's F.D.	Wallsend-Howden oil-burning.
Heating Surface per Horsepower, square feet	3.1	3.3	3.25	2.5	2.25
Horsepower per square foot of grate	7.6	10.0	11.75	17.5	....
Weights:					
Total weight of machinery, steam up	685 tons.	795 tons.	1,750 tons.	1,800 tons.	1,210 tons.
Horsepower per ton of machinery	4.35	4.4	4.25	6.1	9.1
Fuel Consumption:					
Per horsepower	2.375 lb.	1.875 lb.	1.5 lb.	1.35 lb.	0.875 lb.

the succeeding years a number of comparatively small vessels abroad were fitted with Babcock & Wilcox watertube boilers. It may be stated that there is at present at least one merchant vessel under construction on the Clyde with watertube boilers of the Yarrow type.

Before long the tank boiler will be displaced by the watertube boiler in the case of high-powered vessels, and, as owners gain confidence in the new generator, it will be largely adopted for merchant ships of moderate speed. There is a growing feeling that something still better can be done in the direction of large capacity watertube boilers, with higher pressures and greater intensity of steam production. The question is of prime importance to the naval architect, and it will be interesting to watch developments in the near future.

In recent years great improvements and refinements have been made with regard to oil-fuel burning apparatus in the merchant service. The advantages of oil fuel are obvious where oil can be obtained at a reasonable price, and with the projected extension of the system of oil depots over the principal trade routes oil burning will become more general. It is significant that an increasing number of ships are being fitted to burn alternatively oil or coal, as may be the more economical.

Electrical Propulsion

With regard to electrical propelling installations, it is interesting to note in the report of Lloyd's Register for 1916 that two vessels so equipped are being built in the United Kingdom to the society's class. Electrical propulsion is favorably reported upon in America, where it is at present being installed on certain war vessels. It is in the heavier classes of naval work that the field of electrical propulsion seems most promising, on account of interchangeability and the great range of speeds over which good economy can be maintained. In this particular respect the electrical system is superior to all other methods of marine propulsion.

In the merchant service, however, such considerations are of little importance. Still, one cannot say how far the development of the passenger liner may go, and it may be that in such vessels will be found opportunities for the application of electrical propulsion. Powers may be demanded in the future beyond the scope of the geared turbine, and the electrical system would seem to possess all the essentials for the development of the highest powers.

Engine-Room Auxiliaries

In connection with the main engines, it has been stated that the trend of development is all towards the elimination of the reciprocating elements, and it is interesting to observe the same tendency in the case of the engine-room auxiliaries. The driving of auxiliaries on board a vessel by steam turbines or rotary steam engines presents a number of advantages. Alternative proposals have been made from time to time in the direction of driving the various engine-room auxiliaries by electric motors supplied with current from a central generating station, and the proposition has undoubtedly attractive features. The difference in weight and space occupied by auxiliaries on the rotary principle, whether steam or electric, is striking, and the merchant service cannot long remain uninfluenced by this development. Important auxiliaries to which the rotary principle has been applied are the feed pumps, the ventilating and forced draft fans, and the main circulating pumps.

Coming to the main air pumps, it is being proposed to do away with these and provide a steam jet installation to take care of the air liberated in the condenser, and a motor driven centrifugal pump to deal with the condensate from the main condenser.

In many directions there have been developments in connection with steam propelling machinery. A rational design of condenser has been evolved. More attention is being paid to the efficient lagging of hot surfaces, which represents one of the best and safest of all economies. The new applications of the steam turbine have brought in their train improvements in the design and lubrication of bearings. A noteworthy development in this direction is the increased adoption of Michell bearings, by which means the length of thrust block is reduced by more than half. Following this development, the familiar thrust recess will disappear from steamships.

The Internal Combustion Engine

The internal combustion engine demands attention, for it is representative of the spirit of the age. The possibilities opened up by this engine are so attractive from

the shipowner's point of view that before long it will not be surprising to find the steam engine displaced for new tonnage of relatively small power. On the other hand, from the highest powers down to, say, 3,000 shaft horsepower for a single screw, the steam turbine, geared or otherwise, holds the field to-day. Between the two there is a doubtful dividing line, where either the reciprocating steam engine or the oil engine may best serve the purpose, according to the conditions of the particular case.

In considering, however, the prospects of the general adoption of the oil engine for marine propulsion for powers within its prescribed range, it must not be overlooked that the limits of the world's production of oil will prove an important factor.

Tables I, II and III show the progress in marine machinery of (*a*) cargo steamers, (*b*) cross-channel steamers and (*c*) intermediate ocean liners.

Motor Tug with Reduction Gear

IN view of the growing importance of the oil burning motor and the ever-widening scope of its application to marine propulsion, the accompanying plans of a motor tug by the Edwards Engineering Company, of Philadelphia, are timely and of more than usual interest.

The unique feature is the reduction gear which has been introduced in order to enable the boat to compete on an equal footing with the steam tug when handling heavy tows. The average motor tug with its comparatively small propeller turning at 300 to 400 revolutions per minute cannot handle a heavy barge or other vessel with the same facility as a steam tug developing the same power at 90 to 100 revolutions per minute and turning a much larger and higher pitched wheel. A large part of the average tug's work is done at speeds of 3 to 4 miles per hour, or even less, and to get efficient application of power under these conditions the propeller should turn at not above 120 revolutions per minute as a maximum. As the revolutions are increased above this, excessive slip and cavitation result, especially when getting under way and maneuvering.

The propelling machinery shown in this plan consists of a 100-horsepower Fairbanks Morse type "C-O" oil engine driving a 54-inch propeller through a turbo gear. The latter has a reduction ratio of 3.66 to 1, giving a tail shaft speed of about 93 revolutions per minute with an engine speed of 340 revolutions per minute. An efficiency of 98 percent is claimed for the gear, and if this can be obtained the loss of power is insignificant.

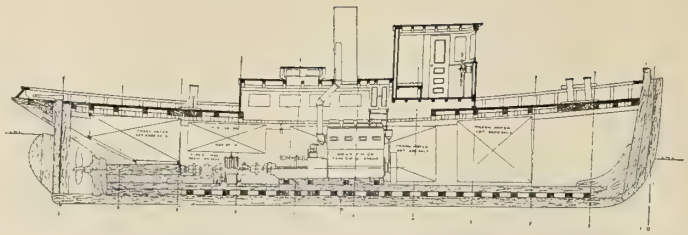


Fig. 2.—Inboard Profile, Showing Machinery Arrangement

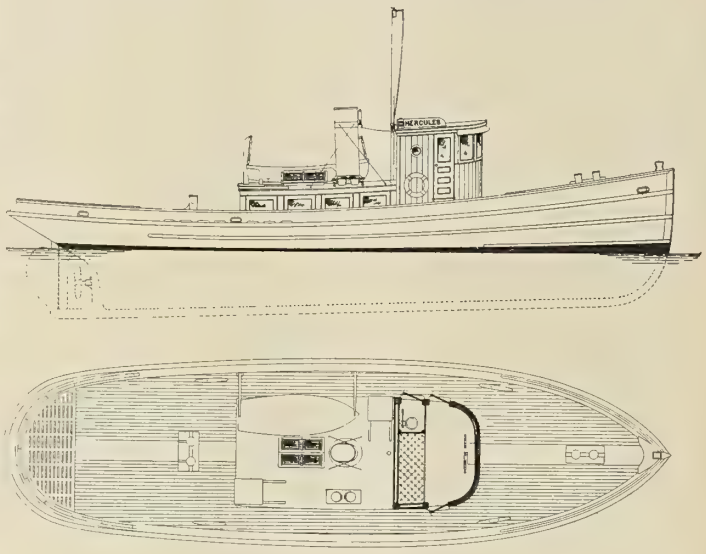


Fig. 3.—General Plans

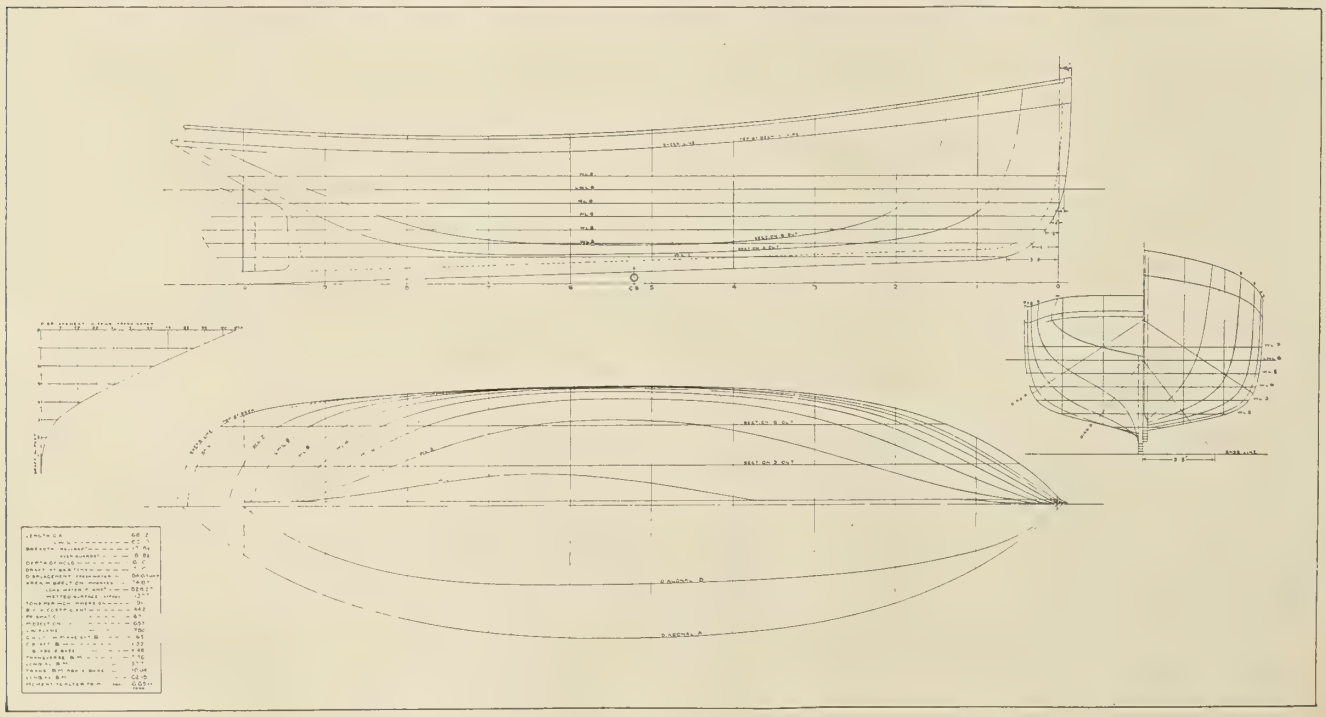


Fig. 1.—Lines of Oil Tug Designed by the Edwards Engineering Company

Auxiliary Ketch Designed by Swasey, Raymond & Page and Built by Camden Anchor-Rockland Machine Company

The boat is intended for use as a fresh water carrier, as well as for towing, and the tanks shown have a capacity of about 8,200 gallons. The construction of the hull is substantial, and follows the usual practice in boats of this type. The cost of operation should be about half that of a steam tug and about one-sixth that of a gasoline (petrol) tug of the same power.

The principal dimensions are as follows:

Length overall	66 feet 2 inches
Breadth	17 feet 8½ inches
Draft (loaded)	7 feet 0 inches

Auxiliary Ketch Uvira

DURING the summer and fall of 1916 the Camden Anchor-Rockland Machine Company, Camden, Maine, built for Mr. R. B. Van Horne, from designs by Swasey, Raymond & Page, naval architects, an auxiliary ketch 79 feet overall, 55 feet long on the waterline, 16 feet 2 inches extreme beam, with a draft of 9 feet. The ketch was put into commission and taken over by the owner in the spring of 1917. She has been named *Uvira,* and is a splendid example of the best modern practice in yacht building.

The hull is built of the finest selected material. The planking is of yellow pine, the frames of Maine gray oak, the decks of Oregon fir, the trunks of teak and the finish in the cabin of white enamel and mahogany. The sails for the vessel were made by Wilson & Silsby, of Boston, and the auxiliary power consists of a four-cylinder model D Sterling gasoline (petrol) engine. Fuel tanks are provided, with a capacity of 400 gallons, and tanks of 300 gallons' capacity are fitted for fresh water.

The yacht is lighted throughout with electricity and also by acetylene gas. Under auxiliary power she makes a speed of better than 8 knots.

Ferro Concrete Vessels*

THE recent experiments in the construction of ferro-concrete vessels have aroused an unusual degree of interest, and shipyards for the construction of such vessels have been, or are about to be, started in several places. Reinforced concrete vessels are by no means new. During the last six or seven years several have been constructed experimentally, but little or no progress on a commercial scale has so far been made. It is probably only the shortage of tonnage resulting from the war and the difficulty of obtaining the ordinary raw materials for shipbuilding which have caused engineers to take up the question in earnest.

It may be of some interest to mention a few isolated examples of ferro-concrete vessels built within the last five or six years. In the autumn of 1911 one of the Danish boards of engineers commenced the building of a barge or lighter of the following dimensions: Length, 47 feet 6 inches; breadth, 13 feet 10 inches; and depth, 5 feet 10 inches; carrying capacity, about 27 tons deadweight. It was built of ferro-concrete, both the design and the construction being in experienced hands. It was taken into use in the following spring. In the design much attention was paid to the protection of the bows and sides against impact, heavy fenders of wood being attached to all the exposed places by means of bolts cast into the reinforced concrete. The inside of the vessel was also effectively protected by wood. This lighter has proved quite satisfactory, and no drawbacks have been found to attach to the material used. Some time previously the Danish Royal Dockyard had ordered some ferro-concrete pontoons for a floating bridge. They served satisfactorily for some time, until one night during a heavy gale from the north, which caused considerable sea in the outer harbor, a good-sized hole was chafed in one pontoon by a piece of floating timber between it and the pierhead, with

* From Engineering.

the result that the pontoon was filled with water and sank, carrying down the other pontoons and the entire bridge. At about the same time the dockyard built some ferro-concrete pontoons for a piledriver float. These have proved satisfactory. They are protected against chafing by wooden fenders on the sides and other exposed parts. The report from which the above details have been obtained states that experience has shown that ferro-concrete, rightly designed and constructed by men skilled in this special branch, may prove a reliable material for floating constructions, including vessels, provided that they are effectively protected against impact and chafing, etc.

In Germany and Holland several small craft have been built of ferro-concrete during the last few years, and quite recently lively interest has been taken in the matter. In Hamburg a ferro-concrete lighter was taken into use in the coal harbor some three or four years ago; the bottom, the sides, the frame, and all the ribs were of reinforced concrete. It comprised some small watertight compartments, but the cargo space was entirely unobstructed. The more exposed portions were also in this case protected by broad wooden fenders built into the concrete.

A Stettin firm built a motor boat of ferro-concrete some five years ago. The vessel was divided into four compartments by bulkheads, which also served to stiffen it. The motor rests on wooden beams, which are attached to a concrete foundation. It is of the two-stroke type, and of 5 horsepower. This vessel has been used as a pleasure boat and apparently has given satisfaction. Also in Holland ferro-concrete boats of modest dimensions have proved efficient. The first ferro-concrete motor boat on the Boden lake was put in the water at Constanz some five years ago. In Russia the use of ferro-concrete vessels for coasting and river traffic has also commenced, a French vessel built at St. Rafaele being accepted as a model. Russia is rich both in cement and sand, in addition to which ferro-concrete vessels are fireproof, which is considered a great advantage in a country where fires on board the river craft are stated to be frequent. For the transport of naphtha products, boats built of this material are considered particularly well adapted.

The instances referred to above are all small boats, which, though apparently satisfactory enough, did not lead to anything approaching a regular industry. This, however, has now been instituted. We have already several times referred to the subject in connection with the Norwegian yard exploiting the Fougner patents. In Sweden one cement-working concern has constructed some barges, used for transport in their own business, and another similar firm is also about to make a start in the same direction. In Denmark, too, the matter has now been taken up.

The Fougner Company at Moss has recently obtained the necessary permission from the Norwegian authorities to commence the construction of two ferro-concrete vessels, without waiting for the final report from the Concrete Ships Committee. The two vessels are of respectively 600 and 1,000 tons, and the fact that the government has given this dispensation shows that a considerable interest must be taken in this new material for shipbuilding. The vessels in question will have four watertight bulkheads, double bottoms of ferro-concrete, and water ballast tanks fore and aft. In deference to the requirements of the authorities these new vessels are built about 20 percent stronger than the yard would normally make them, which, however, does not mean an increase of 20 percent in the weight of the vessel. The dimensions for the 1,000 tons boat, of which we reproduce an elevation, are: Length, 166 feet; breadth, 31 feet; depth, 18 feet. The authorities have stipulated for a particularly ample equipment with regard to life-saving appliances, and the first ferro-concrete vessels will have to undergo special tests before the delivery can take place. The boats resemble the so-called canal-barge type, which is well known both in Norway and Sweden. The propelling power is supplied by two Bolinder crude oil motors of 200 horsepower each. The first two Norwegian concrete vessels are expected to be ready in the course of October. Another Norwegian yard is taking up the construction of good-sized ferro-concrete vessels, and intends to make a specialty of standard types.

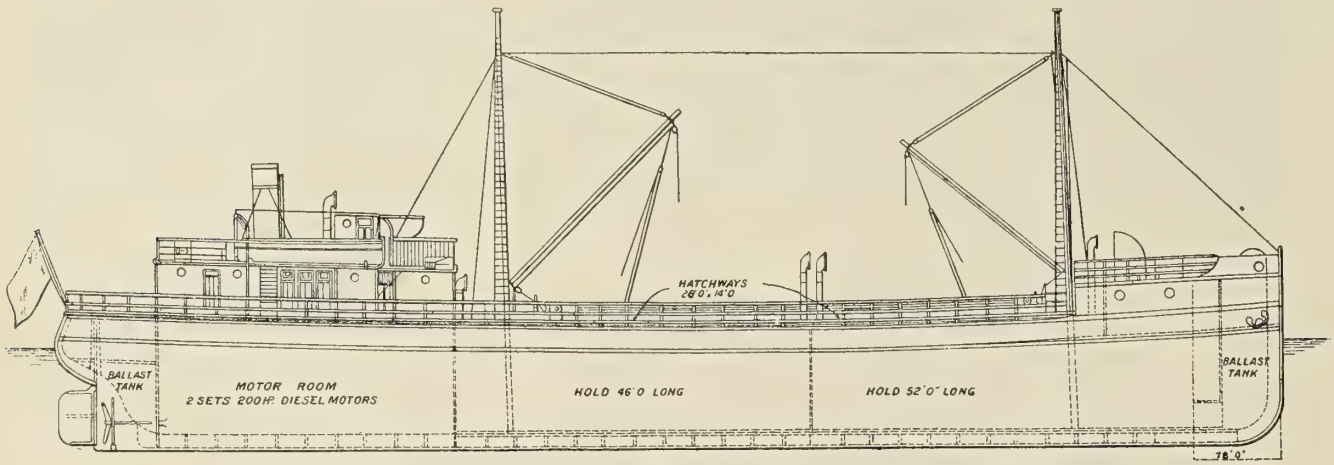


Fig. 1.—Elevation of 1,000-Ton Reinforced Concrete Motorship

In one respect Denmark seems to have taken the lead in connection with ferro-concrete shipbuilding, inasmuch as official rules have been laid down for designing such vessels; neither Norway nor Sweden has, so far, found it convenient to issue such regulations. The Danish rules have been worked out by the well-known expert in ferro-concrete matters, Professor E. Suenson, of the Polytechnical High School, Copenhagen, who is a member of the committee on ferro-concrete vessels. The rules apply to the building of small flat-bottomed vessels of ferro-concrete.

Basis for Calculations

The dimensions are to be fixed on the basis of the Union of Danish Engineers' rules for structural work in ferro-concrete, subject to the following regulations.

The bottom and sides must be at least 7 centimeters (2.8 inches) thick. Flat surfaces less than 8 centimeters (3.2 inches) thick are to be considered as simply supported

unless so reinforced as to be capable of withstanding bending moments in both directions.

The tensile stress on the metal must not exceed 8 tons per square inch; the compressive stress on the concrete must correspond to a factor of safety of 7, or a maximum of 800 pounds per square inch. When the calculated shear stress on the concrete exceeds one-tenth of the compressive stress provision must be made for taking it wholly on the metal reinforcement.

In calculating the strength of the hull the vessel is assumed to be riding on a trochoidal wave of length L, equal to the length of the vessel between perpendiculars and with a height equal to one-twentieth of the length. The cargo compartment is taken to be fully laden with a homogeneous cargo. The calculation is to be made both for the condition when the vessel rides on a wave crest and for that in which it lies in the trough.

The transverse strength is provided for on the hypothesis that the vessel is fully laden, but in such a manner that the cargo is evenly distributed over one-half the total area of the hold while the other half is free. The maximum external pressure to be provided for is that due to the draft

$$\pm \frac{L}{40},$$

where L is the length between perpendiculars. No allowance is made for any distributing effect of the longitudinal girders. The bottom of the hull is taken as a beam subject to a uniformly distributed load q and to the bending moments due to horizontal thrusts H applied at the point at which the sides and deck girders intersect (see Fig. 2).

Fig. 2.

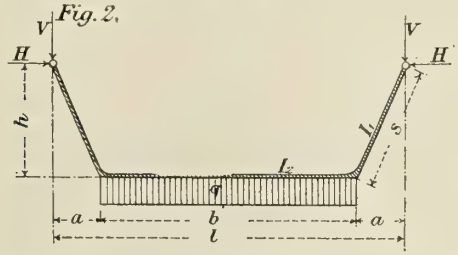


Fig. 3.

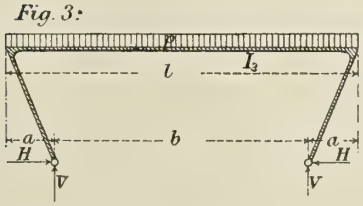


Fig. 4.

Figs. 2-4.—Basis of Strength Calculations

The direct action of the water pressure on the sides is ignored, but is provided for in fixing the value of H, for which the following formula is adopted:

$$H = \frac{q\,b}{4\,h}\left\{\frac{b}{3+2\dfrac{I_2\,S}{I_1\,b}} + 2\,a\right\}$$

Here q denotes the uniform load per square foot on the bottom of the hull, while I_2 and I_1 represent the moments of inertia of the cross sections of the bottom and sides respectively.

The stresses are calculated for the two values of q, viz.:

q = maximum water pressure $- w$,
and q = minimum water pressure $- w$,

where w denotes the weight per unit area of the floor plate.

The side ribs are investigated for the same two cases of loading as the bottom plate, and also for the cases represented in Figs. 3 and 4.

The deck is dimensioned for a load of not less than 700 kilogrammes per square meter plus its own weight.

The through deck girders are assumed to form in conjunction with the side ribs a two-hinged frame, the hinges being at the points where the center lines of the side ribs intersect the center line of the bottom (Fig. 3). The following value is assumed for H:

$$H = \frac{p\,l}{4\,h}\left\{\frac{l}{3+2\dfrac{I_2\,S}{I_1\,l}} + 2\,a\right\}$$

where I_2 denotes the moment of inertia of the deck beam.

The stringer plate c—c (Fig. 4), as a horizontal girder, must be able to transmit the horizontal pressure H (Fig. 1) to the through-deck girders at the end of the hatch. These deck girders are dimensioned for the horizontal pressure represented in that figure and also for the value of H corresponding to Fig. 2.

Watertight partitions are required to withstand water pressure from either side full up to deck level. Safety against local damage by collision is to be provided by giving the vessel such a shape that under normal conditions it can only be hit above the waterline. After completion the hull is to be painted up to the loadline with asphalt, coal tar or similar waterproofing coating.

The Science of Naval Architecture

(*Concluded from page* 481.)

hitherto the naval architect has not been required to consider as regards merchant ships. If present piratical methods of war at sea are to continue, the distinction between merchant and war vessels will necessarily disappear.

As regards vessels of war, experience to date has shown broadly that the science of naval architecture has provided ships which function as anticipated. The enormously destructive weapons of the day are able to destroy in time anything that floats, and without disparaging Mahan's dictum that "Good men in poor ships have always won over poor men in good ships." There is no doubt that good ships are essential even to the best men. Our ships are now to undergo the "trial by ordeal" of the features carefully and patiently planned in past years. May they prove worthy of the good men that man them! There is one final thought, however, which naval architects the world over feel to-day. The progress of late years, which has seemed rapid, will seem slow indeed by the side of the progress and development which must and will be made during the years just ahead of us.

The science of naval architecture, whether applied to vessels of war or peace, has a weighty part to play as the world undertakes to meet the changed conditions of war time and of the time after the war.

New German Battle Cruiser.—According to reports from Berlin, a large battle cruiser, named the *Graf von Spee*, was launched recently at Danzig, showing that Germany has not wholly abandoned the building of capital ships in favor of submarines. It is understood that the vessel is heavily armed, probably with eight 15-inch guns.

CANADIAN REINFORCED CONCRETE SHIPS

Building by Atlas Construction Company, Ltd., Montreal

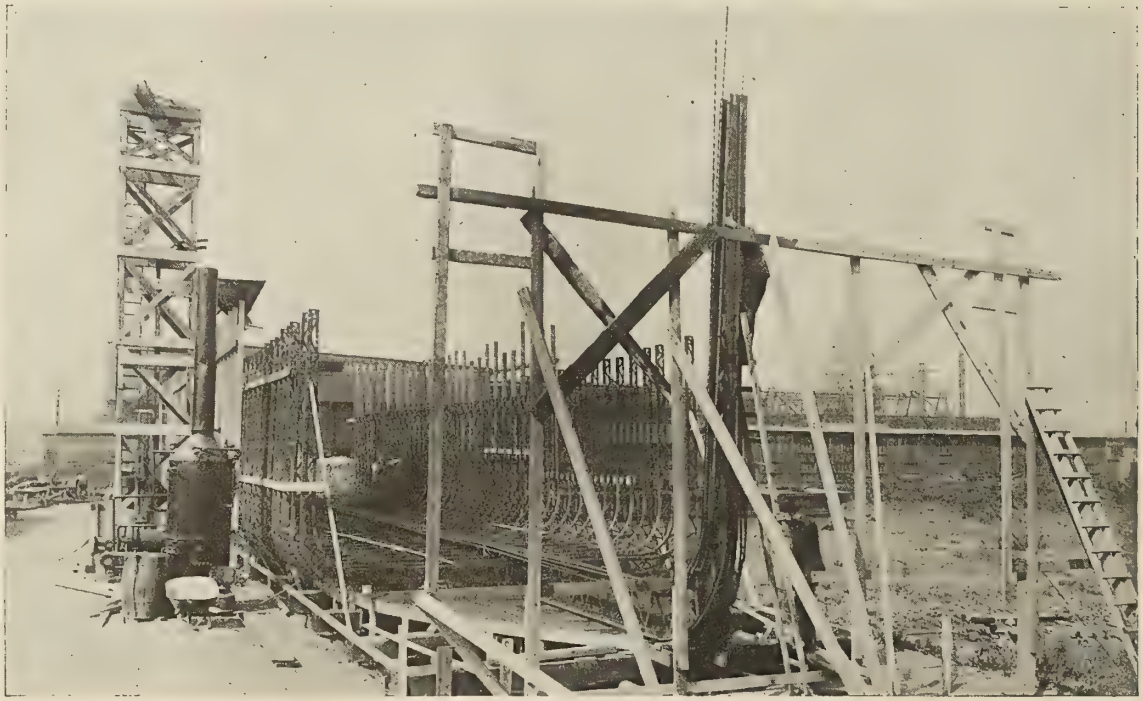


Fig. 1.—Steel Frames of Vessel 5 Inches Wide at Top, 14 Inches at Bottom, Spaced 27 Inches Center to Center

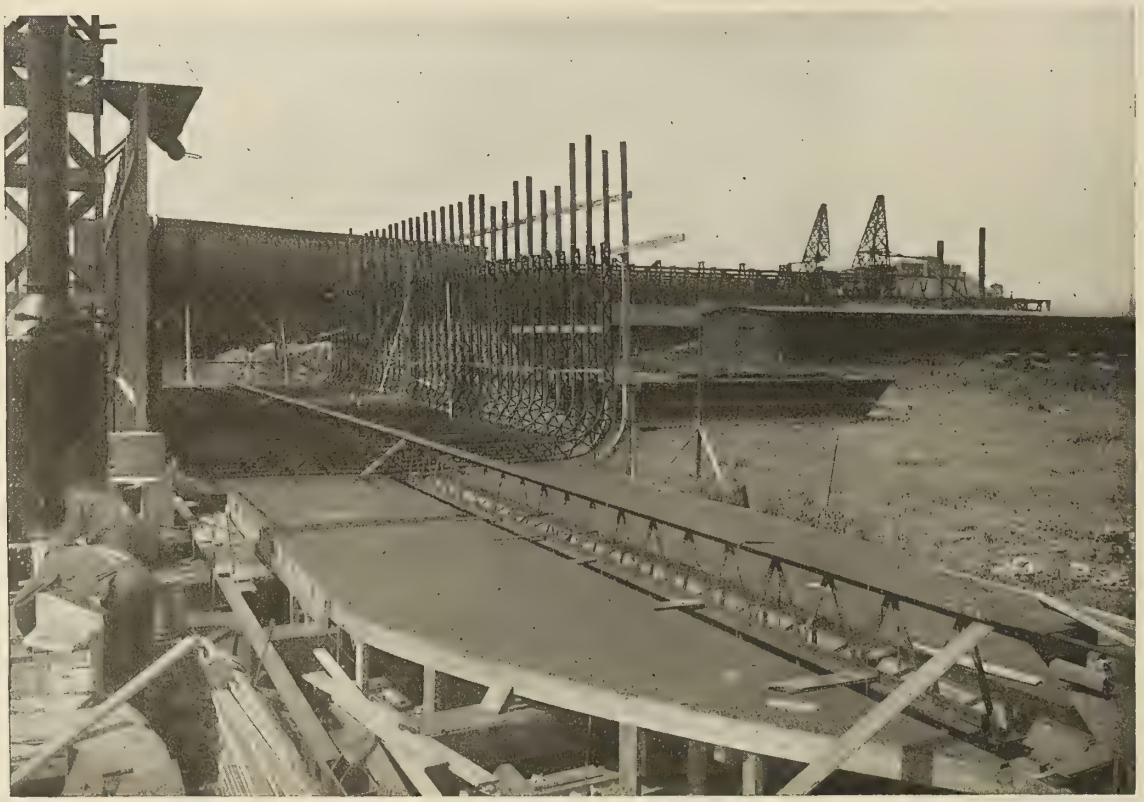


Fig. 2.—Vessel Being Constructed in Accordance with Plans by C. M. Morrsen, C. E., and Prof. Ernest Brown, of Montreal

CANADIAN REINFORCED CONCRETE SHIPS

Building by Atlas Construction Company, Ltd., Montreal

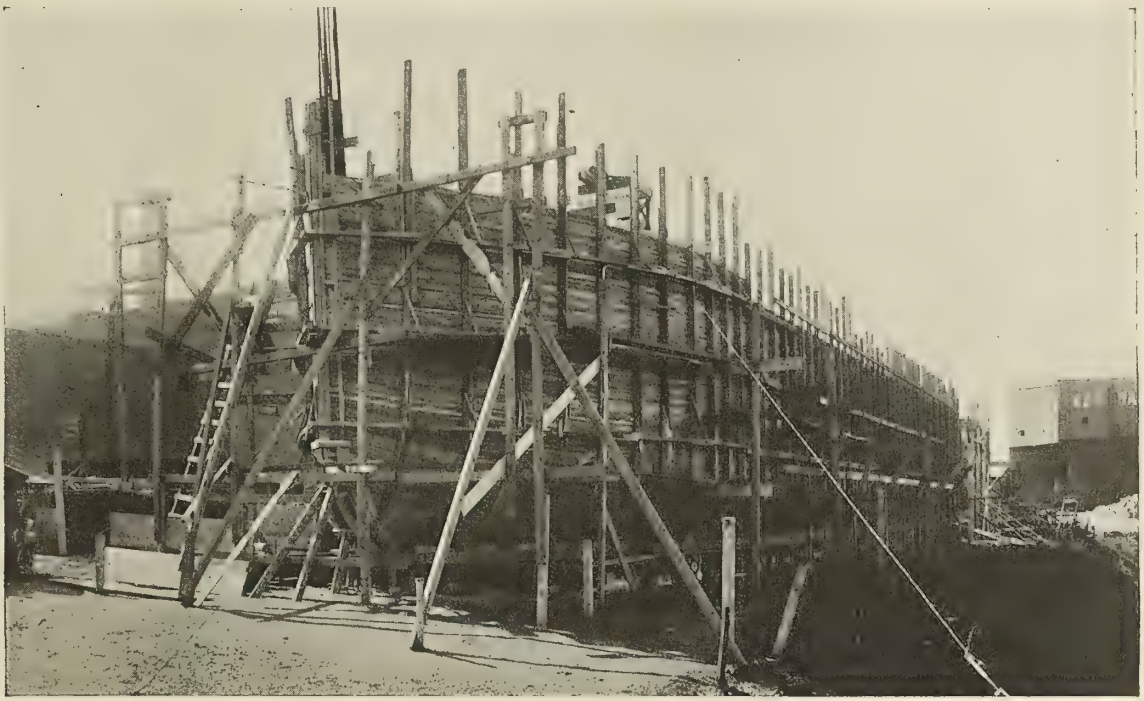


Fig. 3.—Completed Vessel Will Be 125 Feet Long, 22 Feet Beam and 13 Feet Molded Depth, Driven by Single Screw at Speed of 8 Miles per Hour

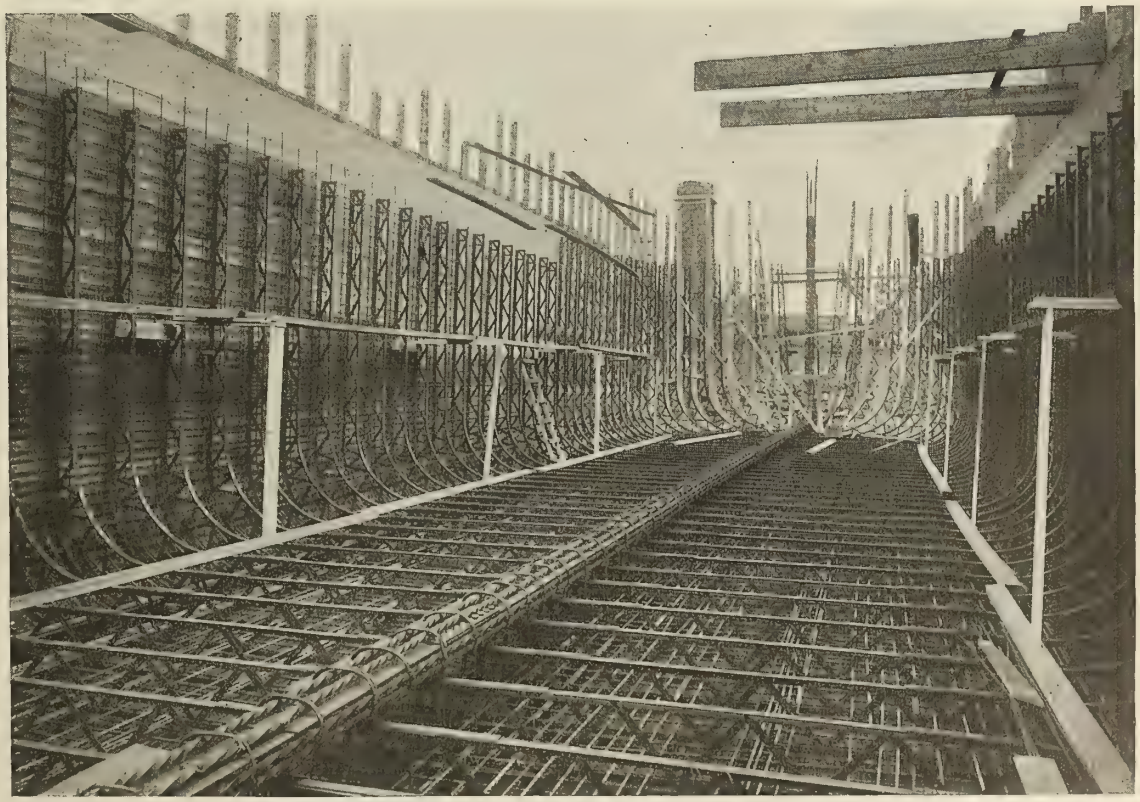


Fig. 4.—Interior View Showing Steel Reinforcements of Hull. Concrete Shell Will Be From 3 to 5 Inches in Thickness

Development of Machinery in the United States Navy During the Past Ten Years*

Refinements in Design of Reciprocating Engines—Comparative Performances of Scout Cruisers—Adoption of Turbines—Forced Lubrication

BY CAPTAIN C. W. DYSON, U. S. NAVY

WHEN I assumed duty as first assistant in the design division of the Bureau of Steam Engineering of the United States Navy Department in July, 1906, I little realized that I was being put in a position where opportunity would be offered me to participate in the greatest advances in marine propulsion that the history of marine engineering has ever known.

During the period covered by this paper we have seen the marine reciprocating engine reach its highest point of development, only to be superseded by the steam turbine, which, as in the case of the older engine, was directly connected to the propeller shaft. The direct-connected turbine has had only a short life, and at the present time is rapidly disappearing from the marine stage, its place being usurped by the mechanical and the electric reduction drives.

Coincident with these changes in the types of steam engines for propelling machinery has occurred the development of the internal combustion engine as illustrated by that most important of the type, the Diesel engine.

Accompanying the advance in main propelling engines were improvements in boilers, in air, circulating and feed pumps; in forced draft blowers; the adoption of oil for fuel in place of coal, and the development of a method for the more accurate design of propellers for the conditions under which they were to operate.

It is my intention to take you through the marine engineering history of these past ten years as I have seen it in order to give you in the limited time at my command as clear an understanding as possible of what has been done and of why it was done.

Conditions in 1906

Upon assuming my duties in the Bureau of Steam Engineering, of the various vessels under construction there were only five whose machinery plants have had any influence upon design during the period of development of subsequent years. These five vessels were:

Battleships—*Michigan* and *South Carolina*.

Scouts—*Birmingham, Chester* and *Salem*.

The two battleships, aside from their interest as the forerunners of the dreadnaught and super-dreadnaught classes of vessel, were of interest from an engineering point of view on account of having the first examples of perfected reciprocating engines for main propelling engines and on account of being the first vessels in the navy to be originally built with superheaters applied to the boilers.

The scouts were particularly interesting, as two of them carried the first installations of turbine-propelling machinery that existed in our navy, the *Chester* being fitted with a four-shaft arrangement of Parsons reaction turbines, while the *Salem* had a two-shaft arrangement of what is known as the Curtis velocity-compound impulse turbines. The third vessel, the *Birmingham*, was fitted with high speed reciprocating engines in order to give a thorough comparison of the three systems.

Valuable lessons were taught us by both battleships and scouts. The lessons were as follows:

Lessons from Michigan and South Carolina

Engines.—The engines of these ships were fitted with piston valves of such length that the steam ports were perfectly straight and entered the steam cylinders in the plane of the diameter. This change from the old system, in which the valves were short and the steam passages long and crooked, permitted the use of ports of larger cross-sectional area, resulting in a decrease in steam velocity through the ports with consequent reduction in steam pressure drop between the valve chest and cylinder, while at the same time a very considerable reduction in the volume of the ports and, consequently, in the total clearance volumes, was realized. The clearance percentages of the old type of engine, referred to the volumes swept by the different steam pistons, averaged about

H.P. cylinder	22½ percent
I.P. cylinder	18½ percent
L.P. cylinders	16 percent

With these first engines of the new type these clearances were reduced to

H.P. cylinder	12⅛ percent
I.P. cylinder	12 percent
L.P. cylinders	11.8 percent

Again, in the old type of engines the cylinder ratios, neglecting clearances, were

$\frac{I.P.}{H.P.}$	2.66	say 2⅔
$\frac{L.P.}{I.P.}$	2.65	say 2⅔
$\frac{L.P.}{H.P.}$	7.046	say 7

These ratios gave an expansion of the steam of about 9, and while such ratios of cylinders tend to light weight, they also produce low economy at full power on account of the low ratio of expansion.

In order to increase the economy of the engines, the cylinder ratios of the *Michigan* and *South Carolina* were made

$\frac{I.P.}{H.P.}$	2.64	say 2⅔
$\frac{L.P.}{I.P.}$	3.83	say 3⅞
$\frac{L.P.}{H.P.}$	10.13	say 10

This change in ratios increased the expansion of the steam to about 12, and reduced the mean effective pressure as referred to the L.P. cylinder from about 55 pounds to 35 pounds per square inch of L.P. piston area.

As previously stated, the boilers of these vessels were fitted with superheaters. The original estimate of the

* From the Journal of the Society of Naval Engineers.

amount of superheat which could be realized from the amount of surface provided was about 100 degrees F., but on trial the superheat at the H. P. valve chest only reached 86 degrees. As the percentage gain in economy by the use of superheat is roughly estimated at 1 percent for every 10 degrees, the superheat gave a gain of 8.6 percent in economy.

The actual gain in economy of the engines of these vessels was, however, considerably in excess of this, although the exact amount is not known, the water consumption of the engines not having been measured. The fuel measurements, however, showed a coal consumption of 1.46 pounds per hour per horsepower of all machinery in operation, which, when compared with 1.775 pounds, that of the *New Hampshire,* one of the last of the vessels having the old type of engine and no superheat, indicates a total gain of 21½ percent. The difference between 21.5 and 8.6, 12.9 percent, is a rough measure of the gain due to the changes in the engine proportions and design. This gain will later be shown to have actually occurred, as in later engines the water consumption was actually measured.

Other Points of Interest

In laying out the main steam piping of the *Michigan* an attempt was made to eliminate all slip joints by the use of generous bends in the pipes and thus rid ourselves of the trouble due to leaks from such joints. The results obtained were very unsatisfactory, as steel piping of the diameters used, 7 inches to 12 inches, was too stiff to expand freely with the amount of bend that could be installed. It was found impossible to keep the flange joints tight, and the entire system had to be replaced by piping fitted with slip joints.

A departure in the material for the main feed system was also made. In previous ships the feed piping had been of seamless drawn copper throughout. On the *Michigan* all feed piping of 5 inches diameter and over was made of seamless drawn steel.

Forced Draft Blowers.—In regard to these, the two battleships also marked the beginning of an epoch; while preceding vessels had all been fitted with blowers of large diameter and slow speed of revolution, driven by reciprocating engines, on these new ships blowers of a type known as the Sirocco were installed, and these were driven by electric motors obtaining their current from the ship's electric plant. While the old-type fans were run at only 225 revolutions, the new type ran at about 650, resulting in much smaller, lighter machines, and by the replacement of the reciprocating engines by electric motors, vastly increasing the durability and the reliability of the system.

The Scouts

These vessels, *Birmingham, Chester* and *Salem,* are chiefly interesting as marking the definite abandonment of the reciprocating engine for light, high speed work and the adoption of the turbine in its place, the reciprocating engines of the *Birmingham* having been fitted for the purpose of obtaining a comparison of the economy and reliability of the two types of machinery.

The engines of the *Birmingham* ran at 200 revolutions, those of the *Salem,* which vessel was fitted with Curtis turbines, at 350 revolutions, and those of the *Chester* at 502 revolutions, the engines developing 16,000 indicated horsepower for the *Birmingham* and 16,000 shaft horsepower for each of the other two vessels, the steam pressure being 250 pounds per square inch, gage.

While the *Chester* was the first example of Parsons turbines in our navy, this type of turbine had been so thoroughly developed in all its details before being pushed forward as a competitor of the steam engine that the installation fitted to the *Chester* was similar in its arrangements and mechanical details to all subsequent vessels in which this type of turbine was installed. The turbines were arranged on four shafts, with an H.P. on one and an I.P. cruising turbine on the other of the two inner shafts. While later vessels with four-shaft arrangements were fitted with backing turbines on all shafts, the *Chester* differed, and backing turbines were fitted to the inner shafts only.

The *Chester* was a successful ship from the outset, as was the *Birmingham,* and both vessels reflected credit upon their builders.

The experience with the *Salem,* however, was far from satisfactory, and the reasons are not difficult to find. In tracing them out it will be well to give a short sketch of the progress of the Curtis turbine up to the date of completion of the *Salem.*

The Curtis turbine is of the type known as "impulse velocity compounded." It had been used quite extensively on shore for driving electric generators before the marine type was designed. The type used on shore being built as vertical units, it became necessary to depart from this form to adapt the turbine for use on board ship.

At this early date the theory of this turbine carried with it the idea that as all expansion of the steam took place in the steam nozzles, wherein steam pressure was changed into velocity, there was no change in pressure throughout the blades of any one stage, and that thereafter there was no unbalanced steam thrust on the rotor of the turbine.

The earliest marine application of the Curtis turbine occurred on the yacht *Revolution* in about 1902. These turbines were provided with only two stages, and developed S.H.P. equivalent to 1,800 I.H.P. at 672 revolutions. A board of naval engineers reporting on the performance of these turbines in 1903 stated: "This plant, being the first large set of steam turbines installed for screw propulsion in the United States, it seems appropriate to mention that the general performance of these turbines, although themselves built rather in the nature of experimental appliances, was quite satisfactory, and they are well adapted as a type of motor for the transmission of propulsive power." * * * "The points in conjecture with regard to these machines being their efficiency and their capacity to compete in economy with the best marine engines, should be ascertained by more accurate tests, both on land and on board ship, where this is possible. The opinion of the undersigned (the board) is that such tests are warranted, and eventually will result in the application of a motor for screw propulsion highly satisfactory to the naval service."

Following this report, the Southern Pacific Steamship Company placed an order with the Fore River Shipbuilding Company for the construction of the steamship *Creole,* to be fitted with Curtis turbines, and in 1905 the Navy Department contracted with the same company for the construction of the *Birmingham* and *Salem.*

The turbines of the *Creole* and *Salem* were made practically from the same patterns, the nozzle areas of the *Salem* being, however, twice as great as those of the *Creole,* on account of being called upon to deliver twice the power. The turbines were built with seven-wheel stages, the drum type of Curtis turbine not having yet appeared upon the scene.

The turbines of both of these vessels were fitted with a type of blading which "hind sight" has taught us was so weak as to be a serious menace to the reliability. The diaphragms between stages were made each in one piece,

and to overhaul the shaft packing of any diaphragm required that the turbine shaft be completely stripped up to and including the desired diaphragm. Further, the thrust bearings were made completely independent of the turbine casings, which was a serious mistake, as these bearings should come and go with the turbine as it expands or contracts. Also, in the case of the *Salem,* while the turbines of the *Creole* were made rights and lefts, those of the *Salem* were made rights only, the port turbine being exactly the same as the starboard, but being turned end for end when installed in the ship. This resulted in adding the unbalanced axial thrust of the turbine to the propeller thrust and unduly overloaded the thrust bearing and its support, and has been a continual source of trouble ever since the vessel went into service.

A comparison of the machinery weights of the three scouts will be interesting, both actual weights and weights per actual power developed on trial.

The total weight of machinery installation, including propelling machinery, auxiliary machinery, piping, boilers and fittings, smoke pipes and uptakes, lagging and clothing, flooring, ladders and gratings, fittings and gear, stores, tools and spare parts carried on board, and pipes, valves, etc., connected to machinery not under cognizance of the Bureau of Steam Engineering was

	Dry	Wet
For *Birmingham*	760.82 tons	843.97 tons
Salem	853.85 tons	908.96 tons
Chester	735.87 tons	800.69 tons

The weight per horsepower delivered was

		Pounds
For *Birmingham*	(I.H.P.)	117.18
Salem	(S.H.P.)	112.68
Chester	(S.H.P.)	89.67

Turning now to the question of relative efficiencies of propulsion, and reducing the I.H.P. of the *Birmingham* to S.H.P. by multiplying by .92, the S.H.P. per knot speed per hour required were as follows:

Knots	10	15	20	24	25
Birmingham	92	156	331	563.5	
Salem	97.5	193	380	600	710
Chester	80.?	190	362.5	604	758

These power results are not particularly consistent, due, probably, to the characteristics of the hulls of the vessels and to variations in weather conditions under which the trials were held. There may also have been errors in the torsion-meter readings, especially at the low speeds, where a slight error would produce the greatest percentage error.

Now, the true measure of efficiency of propulsion is not horsepower required for any speed, but is either steam consumption or fuel consumption required to produce the speed. Where oil fuel is used the personal element of the operating force is reduced to a minimum and measurements of fuel are preferable to measurements of steam consumption, as the first gives a gage on the efficiency of the entire machinery plant, including boilers, while the latter gages the efficiency of the engines and auxiliary machinery only. Where coal is used as the fuel the personal equation of the fireroom force enters largely into the problem, and therefore measurements of steam consumption are to be preferred in such cases.

The steam consumptions in pounds per hour of the three vessels, for all purposes, on these trials were as follows:

Knots	10	15	20	24	24.5
Birmingham	34,000	66,000	134,000	285,500	
Salem	44,000	84,000	150,000	273,000	300,000
Chester	43,200	76,500	138,500	254,800	284,000

The steam consumptions of the main engines, only, at these speeds were

Knots	10	15	20	24	24.5
Birmingham	21,000	50,400	113,000	247,000	
Salem	29,900	66,700	127,300	238,000	261,800
Chester	24,250	56,200	118,000	218,000	244,000

Pounds of water per hour per S.H.P. (main engines only):

Knots	10	15	20	24	24.5
Birmingham	22.82	21.6	17.06	18.26	
Salem	30.7	23.	16.8	16.50	14.75
Chester	30.3	19.72	16.27	15.03	13.34

Attention is called to the fact that while the total steam consumption with reciprocating engines is decidedly better below about 22 knots than that of either the Curtis or the Parsons turbines, even though the latter are fitted with cruising turbines which are in use from 20 knots down, the economies are about even at 22 knots, and above that speed both types of turbines have a decided superiority. Hence, in cases where high speed and light weight were the prime factors to consider in the design of machinery for a vessel, some type of turbine machinery was always to be preferred over reciprocating engines. In cases where the speed of vessel was comparatively low, where high speed was seldom called for, and where economy of propulsion at cruising speeds was of paramount value, the reciprocating engine was, under the conditions of turbine design existing at this early date, very much to be preferred.

For several years after the adoption of turbines as a prime mover for marine propulsion the turbine designers and builders successfully blinded the public concerning the performances of turbine vessels by comparing the steam per horsepower required by turbines with that required by reciprocating engines, and, as shown by the comparison of these amounts for the scouts, the argument was a very good one if the material data necessary to reduce the figures to figures of pounds of water per knot run were not available.

Leaving these vessels, we now reach the starting point of what may be called the modern navy.

1906-1907

During the summer of this year work was begun on the plans of our first two dreadnaughts, and for two, afterwards increased to five, high speed destroyers.

The plans for the dreadnaught were prepared in competition with outside firms, and, while a nominal speed of 20 knots was provided in the design, sufficient reserve power was installed to insure of 21 knots being attained.

When the competitive plans were examined by the department those prepared by the department were adopted and work on the contract plans and specifications at once started.

The machinery space provided in these vessels was such that only reciprocating engines or turbines of the impulse or impulse-velocity compounded type, similar to those of the *Salem,* could be installed. The department plans showed reciprocating engines designed on the same lines as those of the *Michigan* and *South Carolina,* the cylinder diameters as designed being 36 inches, 57 inches and two of 76 inches, with a stroke of 4 feet. The contractors, fearing a lack of power in these engines, later increased the diameter of the H.P. cylinders to 38½ inches, a change which was unnecessary for a speed of 21 knots, but which resulted in considerably higher speed of ship.

The plans also showed Babcock & Wilcox boilers fitted with superheaters, the superheating surface being 10 percent of the total heating surface. While in earlier vessels, in designing the boiler installations, the empirical rule used had been 15 I.H.P. per square foot of grate surface and a ratio of 44.5 to 1 between heating and grate surface, in the design of these vessels the allowance was 18 I.H.P. per square foot of grate and a ratio of 44.5 to 1 between total heating surface, including superheaters, and the grate.

These dreadnaughts also marked our first step into the field of oil-fuel burning. When it was decided to fit these vessels with oil fuel the best sytsem to adopt was not known. The entire field of oil burning was carefully gone over, and it was determined to fit them with that system which would require the fewest number of changes from the ordinary coal-burning installations, especially as in the case in view coal was to remain the principal fuel, the oil only being fitted as an auxiliary to be used when coal became difficult to trim or in emergencies. This requirement made it necessary to adopt a system with which the forced draft blowers required by the coal-burning installation could be used, and we were therefore driven to the now well known system of "mechanical atomization," as it is called, although "pressure atomization" would more exactly define it.

In the arrangement of furnaces for burning either coal or oil the grates are fitted as for ordinary coal burning boilers, and the burners for oil, with the necessary slotted cones for the proper admission of air, are located between the furnace doors. Owing to the limited volume of the furnace between the tube roof of the furnace and the grates, only very limited quantities of oil can be successfully burned in such installations. The whole question of oil burning will, however, be discussed more fully later on.

Adoption of Turbines

Before the advertisements for bids for these two dreadnaughts were issued the first turbine-propeller battleship, the British original *Dreadnaught,* the name of which has been applied as a general name to the "all-big-gun battleship," had her trials, and the results were spread broadcast as a world advertisement for this new form of propulsion. It is spoken of here as a new form for the reason that up to this period it had only been used for much smaller, less important installations in destroyers and in the small British cruiser *Amethyst.*

The installation on the *Dreadnaught* was of the very simplest type, there being four shafts with high pressure ahead turbines on two shafts and low pressure ahead and astern turbines on the remaining two. There were no means whatever provided for increasing economy at low speeds, and the expenditure of steam at these speeds was extravagant.

The new type of machinery, however, immediately struck both the public and the service fancy, and the Navy Department, yielding to the clamor in favor of the new fashion, invited bids for turbine machinery in addition to those for reciprocating engines.

As previously stated, the engine rooms on these vessels were too small to accommodate any other type of turbine than the impulse-velocity compounded type. When the bids were received a satisfactory bid was made by the Newport News Shipbuilding and Dry Dock Company for one ship built according to the department plans and specifications; that is, with reciprocating engines, while the Fore River Shipbuilding Company offered a satisfactory bid with guarantees of performance for a vessel with Curtis turbines.

The turbines offered were in general similar to those fitted in the *Salem,* but, inefficient and troublesome as they proved themselves later in actual service, they did mark one big step in the deevlopment of this now highly successful and economical American turbine, and the development of such a successful completed machine, in my opinion, completely justifies the early experiment and failure in the *North Dakota.* The improvement made consisted in increasing the turbine stages from seven to nine, the last four stages being carried on a drum in place of on separate stage wheels. This was the first appearance of drum construction with turbines of the Curtis and similar types, although it was, and is, the standard method for those of the Parsons type.

Until the advent of the Curtis turbine the Navy Department had been forced to go abroad for its turbine designs, a position which was extremely undesirable, and which justified experiment to the fullest extent to relieve us of the situation.

Forced Lubrication

During the building of the engines of the *Delaware* reports were received of the results obtained with forced lubrication on the reciprocating engines of the British battleship *Africa.* These reports indicated such a great improvement over the ordinary method of gravity lubrication that it appeared desirable to incorporate it in the engines building. Plans were at once prepared by the Bureau of Steam Engineering and forwarded to the Newport News Company, with a request that the matter be taken up at once and an estimate for the cost of the change be submitted to the department in order that authorization for the additional expenditure required for this improvement might be obtained. This was done, and, after some delay, the necessary authorization was obtained.

The original plans of forced lubrication for the *Delaware* contemplated applying it only to main and crank pin bearings and to the eccentrics, depending on the original gravity feed for lubrication of crosshead slides, wrist pins and valve link bearings, and, in conformity with this idea, only those parts having forced lubrication were covered in by the oil casing.

When the vessel was taken out for her preliminary acceptance trials the crossheads and slippers showed a tendency to run warm, and, before the trials, temporary connections through the water service piping were made from the forced lubrication system to these parts. The results obtained due to the forced lubrication were very marked, practically all the vibration and noise to which we are accustomed with the ordinary system of oiling being noticeable by their absence.

The trials, however, demonstrated the desirability of extending the forced lubrication to all the moving parts of the engines, and also that, when extended to the crossheads and slides, a large amount of oil was thrown on the piston rods and lower heads of cylinders, vaporizing on the latter, the oil on the piston rods and the oil vapor being drawn into those cylinders where pressures below the atmosphere existed. This oil then passed over to the boilers and caused fear of trouble due to the oiling up of the water side of the heating surfaces.

Development of the Piston Rod "Steam Seal"

The carrying of oil to the boilers being considered a serious menace, it was imperative that means to prevent it should be devised as quickly as possible, and in aiming at the preventive advantage was taken of the fact that for cylinders in which steam pressures lower than the atmosphere are apt to occur, the piston rod outer packing must be designed to resist pressure from the outside. As the M.P. and L.P. cylinders are those in which this condition exists, and as the high pressures carried in the H.P. cylinders tend to cause a blowing out of steam along the piston rod, cutting off the oil from the rod and preventing the entrance of oil vapor, it was necessary to apply the preventive to the M.P. and L.P rods only. The cure finally adopted is now known as the "steam seal," and consists of an outer stuffing box carrying about three rings of elastic packing with a space between the first or lower ring and the upper two, into which steam of a slightly

higher pressure than that likely to exist in these cylinders is admitted. When the regular piston rod packing is properly fitted and is operating properly, the "steam seal" does its work efficiently. When the regular piston rod packing is not doing its duty the steam seal may aggravate the trouble by blowing through into the cylinders.

In service this system of lubrication proved so satisfactory that little time was lost in extending it to quite a number of the older vessels of the fleet where equally satisfactory results have been obtained. One of the commanding officers of the fleet made the remark to me that we had builded better than we knew, as the reciprocating engine fitted with forced lubrication was quite a different machine from the same engine fitted with gravity feed. Only the other day a report was recived in the bureau from one of the armored cruisers, stating that they had just overhauled their crank pin and main journals after a period of two years' running, and none of the bearings showed the slightest indication of wear. This in itself shows the immense decrease in work required to keep these engines in order over that required in the old days before forced lubrication was adopted.

(To be continued.)

Duties of Newly-Trained Marine Engineers on Merchant Vessels—I

Pointers for the Men Who Will Man Our Emergency Fleet—Service Routine Explained by an Experienced Engineer

BY C. H. WILLEY

THE call is being sounded throughout the United States for engineers to operate the great fleet of ships now being built and those to follow. Recently many ships were held up in port for a considerable length of time for lack of competent engineer forces to man them. Our naval engineers have trained a large number of navy men as engine runners and watch officers to man the seized German vessels. Schools have been established and special courses have been adopted in many of the leading colleges and universities for the special training of deck and engineer officers. Examination standards have been made less rigid, and many other inducements have been offered to attract men to our merchant marine fleet.

In response to this urgent call a great many are fitting themselves to take up the duties of a marine engineer. A large percentage of these men come from the ranks of our stationary engineers, and, with a little training and actual experience, these men will no doubt master the calling to a sufficient degree to entitle them to receive their marine engineer's certificate and a worthy billet on board ship. To these newcomers to the marine profession no doubt a few notes from one who has been following the sea will be welcomed as an aid. It is with that idea that the writer has attempted to scribe the following pointers:

Personal Outfit

It will be found both necessary and desirable to dispense at this time with carrying on board ship any excess baggage or personal belongings. A list of most needed equipment is suggested about as follows:

Prescribed uniforms for mess room and deck use (if no uniforms are required, then two suits of civilian clothes), four suits of light underwear, four suits of heavy underwear, four pairs of lightweight and four of heavyweight socks, four plain dress shirts, two blue flannel working shirts, four light working shirts, one pair dress shoes, two pair thick-soled work shoes, two dungaree heavy canvas or duck jumpers or coats, two dungaree heavy canvas or duck trousers, one dungaree union suit, heavy material, one reefer or medium-weight overcoat, four hand towels, two bath towels, the usual toilet articles and a few reference text-books that pertain to the type of marine engines and machinery of the vessel on which one is to serve.

Socks need be of the strongest material, for there are no women folk to do the darning. Thick-soled shoes will be found almost indispensable for standing watch on hot floor plates and the severe service of fireroom work.

Reporting on Board

About the first thing that the newcomer will want to do after reporting on board, getting acquainted and assigned quarters, is to get familiar with the general run of things below. Usually one of the boys who has been attached to the ship will take the new man in tow and show him the ins and outs of things, but this is only a starter.

One trip around will help, but falls far short of placing things impressively in one's mind. Each steam and exhaust line must be traced individually, noting particularly the several valves and their uses, the bulkheads and slip joints. When the ship is equipped with both a main and auxiliary line, the communicating valves should be well fixed in mind.

Next comes the feed system; this is perhaps the most important and should be carefully studied so as to know just what one can do in tight corners, such as when a feed pump breaks down. If you know the flexibility of the feed system you can quickly get another pump feeding.

The other lines, bilge, fire, circulating pump lines, etc., are all equally important, and must be familiarized to memory. The overhead piping comes fairly easy, but a deal of crawling and work is connected with getting next to that below the floor plates.

When an engineer has studied each line of pipe, its valves, their uses and location and become intimately acquainted with the machinery, he is equipped then, and only then, to be able to act with quickness and sureness in times of emergency, often being able to save both serious disaster to the vessel and the lives of his shipmates. One should never allow the lack of such vital knowledge to place the blame of a preventable happening on his shoulders.

Engineer of the Watch

After reporting to the chief engineer that he has the

hang of things below, the newcomer is assigned to stand watch or day's duty below with one of the other engineers, and becomes posted on the operation of the engines and machinery, and is then given a watch of his own to stand.

Watches are generally stood in three sections, which means four hours on watch and eight hours off.

Repair Duties

Each engineer is assigned to a repair station. Generally there are but three stations—the engine room, the fireroom, the deck or auxiliary machinery. The newcomer will perhaps be assigned to the auxiliary station, and when in port or off watch he will find plenty to keep him busy on the repairs and upkeep of this station. By 'off watch' the writer means to imply that often an engineer has to stand his regular watch and then spend considerable of his own or off watch time in tuning up his repair station. When the ship's complement is sufficient there are but very few extra hours required of one to keep things in good shape, for then there are sufficient junior engineers, oilers and machinists to take care of the actual repair work, so that the engineer in charge has only to supervise the work, but if this be true it is well for the newcomer to learn to apply a little of the hard-earned skill that he has acquired as often as opportunities permit; otherwise one will get rusty and out of practice.

Usually there is provided a small machine shop and blacksmith outfit, for on board ship engineers are expected and required to make nearly all of the repairs, except the larger work, which goes to the yard shops. There will be need for the newcomer to learn to handle shop tools in a far larger measure than his stationary work on shore requires.

Fireroom Notes

No fireroom or boiler room is what might be termed a pleasant place to work in. But when the average boiler house on shore is compared with the stokehold of any vessel one might be tempted to think that tending a boiler on shore was a Paradise task.

About the first thing the writer did when he was introduced to a ship's fireroom was to look around for the best means of escape in case of a boiler accident, or the ship sinking, and perhaps it was a good thing, for a year ago, while serving on one of our cruisers, he was caught in an accident. Luckily, having thought out what I would do, I escaped death, but was severely scalded.

One thing to be borne uppermost in mind—those in firerooms caught in an accident should never attempt to climb a fireroom ladder; the escape must be made by crawling on hands and knees or running, if possible, to the nearest compartment. But should there be no other means of escape except that of climbing the ladder, something must be immediately wrapped around the head and face and a rag or some waste stuffed in the mouth.

While it is more comfortable to work in a scant amount of clothes about the fires, I would seriously recommend that heavy underwear be worn under the regular working clothes and heavy socks worn. This clothing will serve two purposes—that of absorbing the perspiration and of protection against more serious burns if a man is unfortunate enough to be caught in an accident.

Operation Duties

Just a few short remarks on the subject will serve to guide the new marine engineer as to what he will be expected to do. When getting up steam on coal-burning boilers, examine personally, or have a trusted man make sure before lighting off a dead boiler that all cocks and valves of it are in proper order. Oil lamps or candles should be on hand in the firerooms in case of the lighting system getting out of order. Spare gage glasses and packing should also be ready for possible need. Make sure that the dampers will open full and close tightly. Be certain that no inflammable materials are stowed on or near the boilers.

Make sure that grate bars are clear and in condition to receive coal. Men have the habit of using furnaces for stowing shovels, pails, etc. Once in my experience fires were being started in a dead boiler and we received the surprise of our lives on seeing a coal passer come flying out of the adjacent firebox door. He had crawled in there to steal a nap (the ship was in the tropics), and he said that he found the firebox of a dead boiler to be the coolest place to sleep—that when he opened the damper he lay on the bare grates, and went to sleep with the cool draft passing through.

Lighting Off

Try the feed system to see that the checks are working. For lighting off, the water level should be about three inches in the gage glass; some prefer more, but if proper care is used in raising steam and cutting in, this is the best. The higher the water level the longer it takes to raise steam. Cover the grate with 2 to 3 inches of small lump coal not bigger than your fist, leaving about 15 inches of the grate bare near the door. On this bare grate live fire coals are placed, obtained from the auxiliary or donkey boiler. The fire will burn evenly back over the grate. As it burns, thinly spread the live coal with dry, green coal, and as the crust or top ignites, slice it up and shove lightly back; with a little care it will rapidly build up.

As soon as steam issues from the air cock on top of the boiler it should be closed and the try cocks and gage glasses immediately tested to see that they are clear by blowing through each one separately. In a reasonable time (say a minute after closing the air cock) the hand of the steam gage should register pressure that is formed. Should anything be amiss with these fittings the proper time to find out is before the boiler steam is allowed to raise to high pressure.

All coal is tallied by the bucket on board ship. Each bucket holds about 100 pounds. The usual plan is to weigh ten buckets in succession each watch, taking this weight as the average. A tally of the total buckets used per hour is entered in the steam log. All big lumps should be broken with a coal maul at the bunker door by the coal passer, to the size of a man's fist. Firemen have the bad habit of using the back of their coal shovels to break up large lumps that they find in the coal placed for them on the floor plates. This is the cause of many broken shovels.

When getting new boilers started, a considerable amount of fine, unburned coal is worked through the grates; this should be hauled from the ashpan and mixed with new coal; then refired.

While the steam pressure is rising, the auxiliary machinery in the fireroom and engine rooms should be made ready for steam, and the warming-up valves of the main engine cylinder jackets should be opened a little. The bearings of all the machinery are given a generous dose of oil by hand, and the oil wicks placed in, or the sight feeds regulated. Drains and exhaust valves are opened and the machinery jacked over one or two turns.

If sufficient steam is on the auxiliary or donkey boiler the main circulator and condenser can be started, opening the injection and discharge valves first, then starting the circulating pump and next the air or vacuum pump.

When the newly lighted boilers are nearing the working pressure they should be so checked that each will arrive at the blow-off point separately, say, at about ten-minute intervals. This gives time enough to cut in each one with care. The safety valves should always be tested, both by

steam and the hand lifting device. After the valve has lifted, the boiler dampers and ashpan doors are checked up, and the steam pressure allowed to drop to that of the boilers on the auxiliary line, or to within a few pounds. Then the stop is gradually opened. When the main line is cold it must first be warmed up, and all slip joints and drain traps watched. Most main lines have a small by-pass from the auxiliary steam line through which steam is admitted until the pressure is equalized; then the large communicating valves are opened.

Some chief engineers allow the practice of opening all valves of the main line and stops of the dead boilers and raise steam with them open; this warms everything up gradually as the steam forms, but this scheme does not seem to be very popular. It takes considerable time and wastes coal and water.

Before turning over the main engines the stern tube shaft gland should be slacked back just enough to let the sea water drip through. The water service used to keep bearings cool should be examined and turned on.

Bilge strainers should be cleaned and all loose tools and gear stowed away. A plentiful supply of cooling lubricant or solution should be ready for possible troublesome bearings that may have been adjusted too close in port. Generally notes are available as to what has been done to the machinery while in port, and when under way these parts are given special attention.

All engine tell-tales, signals, telegraphs, voice tubes and means of communication should be tested out before reporting ready. An oiler is sent to prepare the steering engine and to stand by it until tested. When all ready to try out the main engines permission is obtained from the deck officer on watch, and then the engines are turned a few revolutions ahead and astern. If all is O. K., then the report is made to the chief engineer that the engineer department is ready to get under way.

Routine

When the ship is well on its voyage, or clear of the harbor, all ventilator cowls should be kept trimmed to the wind.

The speed of the auxiliary machinery is regulated to that of the main engines. The temperature of the condenser discharge is kept around 110 to 120 degrees to retain feed heat; this can be done on direct condensers by regulating the injection valve. The jacket steam pressure is reduced to just sufficient amount needed to keep the cylinders hot; oil wicks or feeds regulated to suit the standard speed.

Fires are cleaned in each new furnace once every 12 hours, but as a rule there is no need to clean new fires until they have burned a day. But all clinkers should be pulled as soon as they form.

Fires to be cleaned are first burned down to as near ash as the steam pressure will permit. While burning these down, the wing fires are built up to supply the new fire cleaned section of the grate. Time spent in cleaning should be reduced to a minimum, as during the cleaning, if care is not used, the steam will drop in pressure. Do not try to clean too many fires at one time.

Tubes must be cleaned free of soot and dirt once a day or they will soon plug up the draft passage. This is done with air pressure or live, dry steam used in flexible metallic hose with pipe lance leaders through the connection doors.

Coming Into Port

When it is known at what time the ship will anchor, the chief engineer issues orders as to which boilers shall remain in use for auxiliary. Then the remaining boilers are allowed to be worked or burned down as much as possible with due regard to the need of steam for anchoring maneuvers.

When dying out the fires it is best to close the dampers and ash pits and allow them to die slowly; this is best for the boiler and brick work.

In the engine room the main line stops and reversing engine are secured to prevent any accidental turning of the engines. Drains are opened, oil wicks and feeds are shut off, all cups and oil pipes leading to bearings are covered to prevent dirt getting into the journal. Gaskets or fillers are laid over ends of bearings. Air and circulating pumps are slowed down. A vacuum is kept on the engine until it is dried out and steam is on the main line. When able, the engine-room machinery is all secured and regular port duties of cleaning and adjustment are taken up.

(*To be continued.*)

Why Is A Gun Foundation?

Arrangement and Construction of Foundations for 5-Inch Guns on Merchant Vessels

CASEY had left us and gone to the "bush leagues." One of the first jobs he had been given was that of putting a gun foundation on a tanker which was about finished but which had to be supplied with a couple of guns, so that she could make her way with better success among the submarines. Casey's experience had been varied, but guns on merchantmen was something new. He was stumped, or thought he was, and had sent an S.O.S. call to "Old Mac."

Mac had written him a long letter. Before he mailed it, however, it occurred to him that its contents would benefit young Stevens. He, therefore, brought in his letter and gave it to young Stevens, with the suggestion that he read it and drop it in the mail box at noontime.

Young Stevens read it—studied it, in fact. With the idea that it might help other "bush leaguers," and may interest some of us in the major league, here it is:

Mac's Letter

DEAR CASEY:

You are worrying because that fellow you complain of is throwing a better bluff than you are throwing. Has he got your goat? If he is responsible and does not tell you the kind and number of guns and where he wants them located, why should you worry? Sit tight, smile and watch him try to make you do something that neither of you can do.

You are not telling me very definitely what you want to know, but I suppose you want to gather up what you can while there is time, so here are a few items as they occur to me.

These auxiliary passenger boats have four guns, located port and starboard on the forecastle, and aft on the quarters. Four or five guns are used. The gun mount or pedestal base of the gun is bolted down to wood planking on the deck and enclosed in an angle bar that has a vertical flange which comes up to within about a half or three-quarters of an inch of the top of the wood, and a calked flange to the deck to suit the deck riveting. The wood is preferably teak, 3½ inches to 4 inches thick, and should have a level surface and not follow the camber or sheer.

Strengthening the Deck Plating

The deck plating in way of the foundation should be doubled to about 1 inch thick to give good bearing for the bolts. Another plate about one-half inch thick and called the washer plate takes the bottom ends of the bolts. This plate is loose and not fastened to the deck framing except by clips that prevent its falling out if the bolts are removed. This plate may be in several pieces and covers the wood filling of pine that is put in under the deck plating.

This wood filling stiffens the deck and allows a certain amount of play that makes the foundation resilient. The wood filling extends down to within two or three inches of the bottom of the beams or girders and is nicely fitted and sometimes filled with tar or pitch.

The holding-down bolts are made of high tensile steel. They are fitted in the gun mount and have a hexagon nut with a split pin on the bottom. They are a tight fit in the wood filling, being reduced about a quarter of an inch in diameter half way into the woodfilling. The size, number and location of these bolts are to be gotten from the detail of the gun mount to be used.

With no more than the maximum depression, the gun should have an unobstructed line of fire at an object on the surface of the water not more than 50 to 60 yards distant. The center of a 5-inch gun, as I remember, is about four feet above the deck, and the angle of depression is about 10 degrees.

A modern high powered gun of say 5 inches diameter bore has a trunion reaction of about 100,000 pounds or less and weighs about three tons. This trunion pressure depends upon the muzzle energy and recoil arrangements of the gun; and in the same gun with less muzzle energy, may run down to 50,000 pounds. This trunion reaction is the maximum reaction or kick of the gun on the trunion. These figures may be of service, if you want to attempt to analyze stresses, etc., in supporting beams and girders in any particular case.

Location of Guns on Freighters

On a tanker or freighter they are now fitting two guns, one forward and one aft on the centerline of the ship. As before, they should have an unobstructed line of fire at an object 50 to 60 yards ahead or astern on the surface of the water. They should train as far to port and starboard as possible. Deck space is not always available aft on these boats and there are obstructions forward, so that the guns may have to be mounted up in the air—clear above the deck on a platform over the windlass forward or on top of the deck house aft. The same kind of foundation directly under the gun is used as when mounted on the deck, except that it is raised up in the air and supported by girders and webs from the structure of the ship. Four girders crossing at right angles under the edges of gun mount and made up of ½-inch plate and 5-inch by 5-inch by ½-inch angles make a good scheme. For ordinary spans and a 5-inch gun, a girder of 12 inches to 15 inches deep is about right. Five-inch solid stanchions at the corners should be fitted if possible, and the framing should be carried down through two or three decks and distributed well into the main framing of the ship.

Working Platform

With a gun mounted in the air this way a working platform has to be provided for the gun crew. It is made large enough so that it extends about two feet beyond the working circle of the gun. It is supported from the main gun foundation by brackets and beams and can be plated and stiffened as for a housetop. For a 5-inch gun this working platform would be about 28 or 30 feet in diameter. It should have a coaming and permanent stanchions that are clear of the gun and that support a life line and weather cloth. The plating may be perforated or scuppers fitted. Wood should not be used on this platform, because it splinters and is inflammable. If the adjacent parts of the ship are wood, then wood may be used, because the evil of splintering wood, etc., cannot be avoided entirely.

To the rear of the gun the platform should be widened out to provide space for a ready service ammunition box and an observation station for a couple of men. The ready service box is a watertight wooden or metal box having a hinged top and front big enough to hold a dozen to two dozen shells. Such a box for a 5-inch gun is about 5 by 2½ feet and 4 feet deep. The observation platform has a pipe rail and high stanchions supporting a substantial weather cloth.

The platform should be readily accessible by a companion or ladder located at the rear of the gun, and all deck fittings, such as boat davits, ventilator cowls, etc., should be portable, so that when it comes time to shoot there will be nothing permanent in the way.

Magazines and Gun-Crew's Quarters

A magazine below the water line will be required. Two small ones near each gun or one large one will do. Two hundred rounds to a gun or four hundred rounds for both guns is none too much if some of the reports are true that these boats often run out of ammunition blazing away at a submarine. Locate the magazine aft if possible. Make a watertight compartment out of it, or if of wood, build it clear of the decks and bulkheads, well braced and sheathed with galvanized sheet iron. Provide a strong, tight door. Don't put any light in the magazine, but arrange them outside to shine in through light boxes or in through the door when it is open.

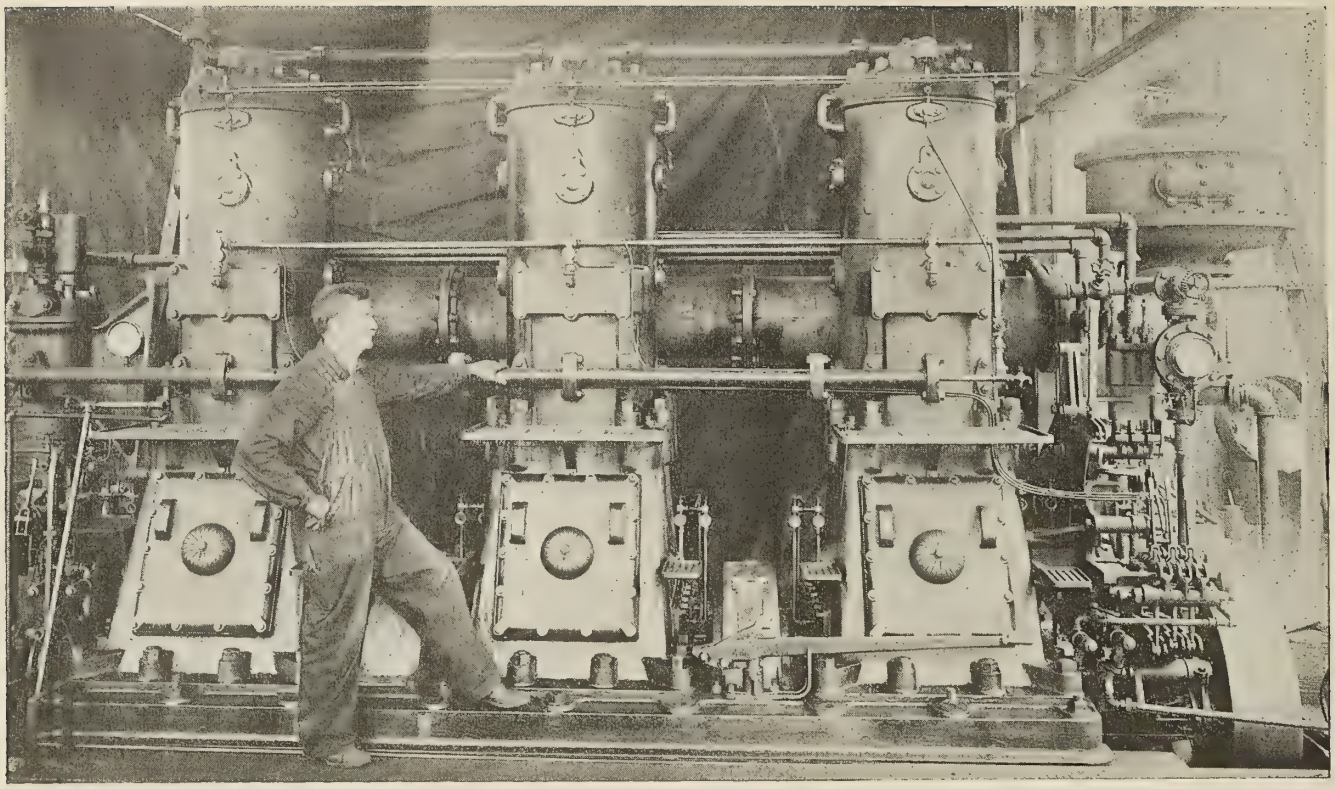
This magazine should be ventilated and provided with a flooding connection, 2 inches diameter, from a fire main.

The ammunition is hoisted up to the platform by a small davit and a block and tackle. The means of getting it out of the magazine depend upon the location of the magazine. Don't forget that sometimes the simplest and best way is for a man to pick it up and carry it.

First class quarters must be provided for the gun crew. There is a commanding officer, who can be nicely located in the spare stateroom. Two petty officers have another room, and the crew (7 men for a 5-inch gun) have to be berthed and messed separately from the ship's crew. An additional and separate lifeboat must be provided for the gun crew.

There are other things to be looked out for, such as alarm bells, telephones, etc., but these can be taken care of when the gun representative lands on the job. He knows his busines and is particular enough to have everything properly installed.

Good luck, Casey! Mac.



Three-Cylinder, 250-Horsepower Engine; Cylinders, 16 Inches Diameter by 24 Inches Stroke; Piston Speed, 720 Feet per Minute

Direct Reversible Marine Oil Engine

Three-Cylinder Type of from 75 to 500 Brake Horsepower Built by Seattle Machine Works, Seattle, Wash.

A NEW type, direct reversible marine oil engine has just been completed at the Lander street plant of the Seattle Machine Works, Seattle, Wash. The designer, Mr. Carl Engel, who was engaged by the Seattle Machine Works about a year ago, has been actively engaged in internal combustion engine construction for over nineteen years, and his practical experience in that line as superintendent in a large Eastern manufacturing plant has made it possible for him to work out an entirely new design of engine, not only eliminating all unnecessary complicated parts, but also embodying new improvements which are important to a successful running oil engine. It has been the designer's endeavor to build a simple, accessible and easily operated engine, made fool proof; with liberal strength and dimensions, and constructed to stand up under all conditions. It operates on fuel oil or any oil that is suitable for oil engines. It is direct reversible with compressed air. The reversing mechanism is a new invention (patent on which has been applied for), and has already been installed by the Seattle Machine Works on several Eastern engines. This company now has orders for four more reverse mechanism installations.

The engine has three cylinders, each 16 inches diameter by 24 inches stroke. The castings for cylinders and pistons are made of a special mixture of close-grained cast iron. The cylinders and cylinder-heads are tested separately under hydraulic pressure. All openings on the cylinder or crank case are covered with flanges and are placed in such a position that these can be readily removed without trouble. The cylinders are water jacketed and have ample water circulation from a pump, which is operated from the main shaft.

Crank Bed Plate

The crank bed plate is cast in one piece and is constructed to take care of the crank shaft and bearings in itself so that the whole top of the engine can be easily removed without disturbing the shaft or main bearings. The strength and construction of the crank bed plate make it almost impossible to draw same out of line and cause hot bearings. It has, furthermore, sufficient rigidity to eliminate any possibility of its working loose from its foundations providing these are made in proportion to the size and strength of the crank bed plate.

The crank shafts are made out of high-carbon, open-hearth steel, and are made over-size to Lloyds' requirements.

The dimensions of crank pins and main bearings are such as to obtain a very large bearing surface so that the pressure per square inch is low enough to keep the bearings cool under any load which the engine may carry.

Cylinders Have Individual Fuel Pumps

Each cylinder has an individual fuel oil pump of the simple plunger type with self-contained ball checks. The centrifugal force of the governor weights is impacted to the sliding device which is connected to all the rocking bell cranks for the fuel injection pump. This is operated by eccentrics on the main shaft, on which the sliding de-

vice is working in such a manner as to cause a long or short stroke of the injection pump. According to the load the displacement of fuel is in direct proportion to this variable stroke.

Governor

The governor, of the centrifugal balanced type, is not affected by the rolling of the ship. It is driven directly from the main shaft and in conjunction with the plunger of each pump through the sliding arrangement before mentioned regulates the amount of oil injected according to speed and load of the engine. In any case of emergency in which the loss of a propeller or the breaking of the shaft would speed up the engine a few revolutions above its normal speed the increased centrifugal force on the governor weights will stop the engine and thus avoid more damage.

The Engel air distributing valve with which this engine is equipped can also be attached to any marine oil engine for direct reversible purposes. The valves are in motion only when starting and reversing the engine so that there is no wear on any part connected with them while the engine is in operation. The same eccentrics which operate the fuel injection pump also operate the air-distributing valves.

Reversing Mechanism

When the reversing lever is pushed out of its neutral position in either direction it will immediately shorten the stroke of the injection pump and at the same time the air distributor will start to open according to the time set for each cylinder, which will receive the full volume of air required for the engine. When the lever is put back to the center of the quadrant the oil injection pump will resume its full stroke, and the engine will take the full amount of fuel oil required according to the speed and load as regulated by the governor.

This engine has no lubricator or force feeder requiring a lot of copper tubes leading to the cylinders, bearings and other working parts such as are usual on other oil engines. The lubricating system is very simple in construction. A plunger type pump, which is always in operation with the engine, takes care of the lubricating oil, which is forced through a pipe and remains under a certain pressure against sight feed valves, which are attached to all the main bearings. The pressure of the lubricating oil is regulated by a by-pass valve according to the amount of oil required for each bearing, and is indicated by a gage.

Method of Lubrication

There are no lubricating oil pipes attached to the cylinders, as the piston itself carries the oil required for its own lubrication. Crank pin, wrist pin, cylinder and piston receive their lubricating oil through a plunger pump attached to the inner wall of each crank case, and this also is regulated by a single sight feed valve which is connected with the same pipe from which all the other bearings receive their oil. In addition to this lubricating arrangement a small hand pump is attached close to the other oil pump, which can be used immediately in case of emergency or when oil is required before starting the engine. It is also of great advantage to the operator or attendants and does away with oil cans, which are often not at hand in time of need. This plunger type oil pump takes the oil directly from the main oil storage tank.

The inclosure of the crank case does away with all danger to inexperienced attendants. The rigidity of the main crank shaft bearings and the slightest leakage past the piston, which is often noticeable in open crank cases, has been entirely and permanently overcome on this engine, it is claimed, by passing a charge of pure air unmixed with fuel oil through disk valves into the crank case. This air is compressed by the downward stroke of the piston, which allows it to pass into the combustion space.

In order to prove complete and perfect assembling and developing of power as rated, a test has been made covering a period of approximately three months. The fuel oil consumption shows at a brake test of 250 horsepower, with a speed of 180 revolutions per minute, seven-tenths of a pound per horsepower per hour. During the test the engine was subjected to an overload of 15 percent, the 16-inch bore by 24-inch stroke giving a piston speed of 720 feet per minute.

This type of engine is built in units of from 75 to 500 brake horsepower.

Use and Care of Pneumatic Tools for Shipyards

BY GLENN B. HARRIS

PERHAPS in no other branch of the metal industry have pneumatic tools proven of greater value than in the shipyards of the country engaged in the building of steel ships.

The chipping hammer has proven of incalculable benefit in all chipping operations, and of equal value in calking. In the latter operation it is, of course, used on all side and deck seams as well as on bulkheads and tanks, and its gain over hand work is probably three to one, while the character of the work performed by it is superior to that done by hand, inasmuch as the blow delivered by the pneumatic hammer is always of a uniform character, due to a practically constant pressure, while it is said that the work of a man by hand is not so marked, owing probably to the fact that he is fresh and vigorous in the morning, and wanes in strength as the day progresses. Calking by machine, even when subjected to high pressure, seldom shows a "sweat." In the boiler shops of shipyards it is also utilized to the same advantage.

In chipping, the pneumatic hammer is utilized for all operations of that character, and, as is well known, there are many of them required in ship construction. Unique uses to which the hammer has been put are many and varied. It is utilized to cut and finish up patch bolts on the eye of a propeller; in making up patch plates on boss and propeller eye, in cutting out hawse holes, and work for which the hand hammer or mallet is ordinarily adapted. The chipping hammer unquestionably does the work of at least three men by hand.

In an amplified form the pneumatic hammer has proven also to be of the greatest benefit to the shipbuilding industry. Reference in this connection is here made to the riveting hammer. The riveting hammer is simply the chipping and calking hammer in enlarged size. The piston diameter is not materially increased, but the length of stroke is extended from that of the chipping hammer, which is about 2 inches or 3 inches to 6 inches, 8 inches or 9 inches.

The hammer as originally introduced for shipyard work was mounted in various devices for ship riveting. There was a special machine for driving flush deck rivets, which consisted of a heavy, cumbersome frame carrying a pneumatic hammer of extraordinary proportions. This machine did the deck riveting, and a man with a chipping hammer cut off the head, after which in some instances the rivet was driven further into place, although unnecessary, except for the purpose, perhaps, of smoothing down. This was an absolutely unnecessary proposition, as the ordinary pneumatic hand hammer would perform the work with greater efficiency and in less time.

In the case of outside or shell riveting an apparatus was provided for holding the riveting hammer. This has since been dispensed with and the usual type of riveting hammer employed to take its place.

The riveting hammer has worked a revolution in the construction of steel ships, not only permitting their construction in a short period of time, but lessening materially the cost of production.

An ingenious device which is a modification of the pneumatic hammer is utilized for packing condenser tubes. A leaky condenser on board ship causes a great deal of trouble and it is claimed that the cause of leakage in a great many instances can be directly traced to the fact that the packing laces are not carefully laid in. Twelve to eighteen tube ends can be packed per minute, and experts have exceeded this number in the same length of time. As with the calking and chipping hammer the work of the packing tool is of a uniform character, and each tube is packed precisely like its neighbor. The machine is light and easily handled, and is undoubtedly of value for the purpose for which it was designed.

The air drill is of equally great saving in the shipyard, as is the pneumatic hammer, and the uses to which it is put are varied and numerous. In addition to all drilling operations requisite in ship construction, this conveniently portable machine is used to greater advantage in reaming operations, for boring in wood and different grinding operations. What is known as a close corner drill is also marketed and is of particular use and has been almost universally adopted in shipbuilding for rolling the outer tier of flues in boilers; also for tapping and other work in close quarters. The pneumatic drill is also used to great advantage in drilling out rivets in the shells of ships. Various new uses are continually suggesting themselves for the employment of this tool, and they all make for economy in production.

Proper Handling of Pneumatic Tools

In most yards the workmen handling pneumatic tools are not mechanics, and the machines require careful handling to obtain the best results. This is hardly to be expected of unskilled labor. Like all other classes of machinery, these devices must receive proper lubrication to insure the best results, and this, with their proper cleaning, is most essential.

The writer, from a long experience in this line, knows full well that the material used in all these tools is the best obtainable. There have been long periods of experiment to get what will stand the wear and tear to which they are subjected. The moving parts in both the hammers and drills are accurately and closely fitted, and when proper lubrication is neglected these fine pieces of machinery wear rapidly and in a very short time refuse to work.

As the air which is taken into the compressor generally contains some particles of grit and dust, the working parts of the hammer and drill are likely to become clogged with this foreign matter, causing the ports to become closed and the tools rendered inoperative. The use of a poor grade or heavy-bodied oil will also cause the same trouble. The best plan to follow in a case of this kind is to cleanse by introducing gasoline (petrol) in the air induction. This will dislodge any extraneous matter and cuts the thick oil, both of which can then be removed by blowing air through the hammer.

Another great source of trouble and annoyance is sometimes located in the pipe line. Moisture in the air will rust the pipes through which it is conveyed, and if the tools are connected up without first blowing out the pipes a sediment is likely to be blown through into the tool, causing valves or pistons to stick. Rubber deteriorates rapidly and dislodged particles may blow through into the tool and render it inoperative.

It frequently occurs that a workman will make complaint that his hammer or drill is not working properly, or that it will not run at all. In a great many of these cases, on the machine going to the tool room, it is found that sediment or pieces of rubber were at the bottom of all the trouble, and when cleaned with gasoline (petrol) and oiled they would work perfectly.

In a great many of the plants of this country a special tank is provided, in which the tools are immersed at night, then blown out in the morning and thoroughly oiled with the best grade of light machinery oil obtainable. This will not only greatly prolong the life of the tool, but much superior results will be obtained in all ways. It is also a wise plan to make use of a strainer at the induction end of the tool. It is remarkable what an accumulation of grit and dirt will be gathered in a short space of time under the usual conditions in a shipyard.

Harmfulness of Short Pistons

One of the most flagrant abuses to which the pneumatic riveting hammer is subjected is the use of short pistons. The riveting hammer was designed with all its parts properly proportioned to meet the requirements of various classes of work for which these tools are adapted. The workmen have discovered, however, that a piston reduced from the standard of 4 inches in length to 2½ inches delivers a more rapid blow and for a time performs faster work and with greater ease of holding. Short pistons, however, not having the body of metal in them, are subject to crumbling, due to the hard work to which they are subjected. The small, broken parts cut the cylinder, and if the latter is not damaged beyond repair from this cause it is only a question of a short time before the hammer is irreparably ruined.

When cylinders are cracked and handles and rivet sets broken the hammers should be examined to determine whether the workmen have in service a short piston. They have devious ways of obtaining them. The only sure way to determine whether a short piston has been substituted for the proper one is to have them examined while in service, as it has been found that the workmen carry the short pistons with them, make an exchange after taking the hammer out of the tool room and then replace the proper piston at the end of the day, when the tool is returned to its proper quarters.

Another abuse of pneumatic tools is the taking of them apart and the putting of them together again. Some repairmen, instead of using a wrench or soft hammer in loosening or tightening the handle of a riveting or chipping hammer, will employ a hard hammer, badly battering the parts and sometimes breaking them. The finished parts should never be struck with anything but a lead or copper hammer, and even when this is done care should be used not to unnecessarily strain the threads between the cylinder and handle.

It will pay any shipbuilding plant to employ a man who is competent to look after the pneumatic tools and see that they are properly cleaned and lubricated. In cold weather it is a wise proposition to warm up the tool. This can be done at the rivet forge. With the blow of the piston in the riveting hammer on the set when the parts are cold breakage is likely to occur. In some yards with which the writer is acquainted it is a practice to offer a premium to the workman taking good care of his tool. This should result in a saving to users of pneumatic appliances of all kinds.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

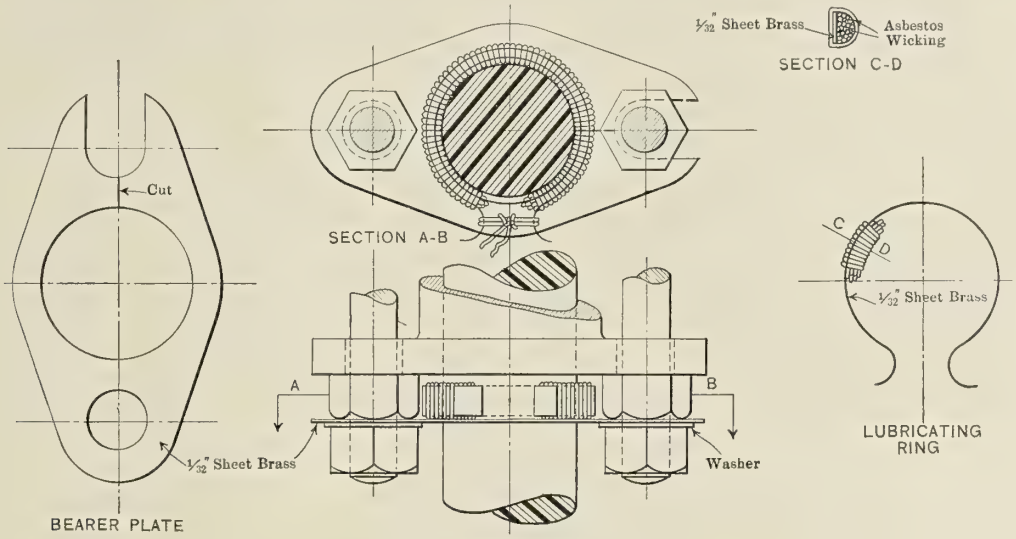
This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Lubricator for Piston Rods

The sketches shown herewith illustrate a lubricator for piston rods, which gives perfect results and which is very simply made, attached and operated. In sixteen years' experience as an engineer the writer has never seen this type of lubricator used by others. It will not only lubricate the piston rod, but it will supply an economical amount of lubrication to the cylinder walls, which is a unique feature and one which is very useful in systems using a hot-well.

One good swabbing every four or eight hours is sufficient, as the asbestos wicking holds the oil and feeds it to the rod as needed.

J. F. Knoblauch,
First Assistant Engineer, S. S. *W. C. Teagle.*
Baton Rouge, La.



Details of Efficient Lubricator for Piston Rods

A Visitor

Confidence in one's own ability is a valuable asset when not allowed to be over-developed. By this the writer means that one should never get to the stage where he feels that he is not susceptible to receiving advice from the older men in the business. Willingness to listen to a retired veteran chief of marine service, who was crossing the Atlantic on board the ship on which I was serving as chief, gave me some very valuable information that helped me later on in obtaining a berth with more pay and added attractions.

The veteran chief was trained in service and had practically little textbook learning, yet he was plainly a man of keen executive qualities, and some of the advice given to me in regard to handling the human factor of marine engineering proved that he had been a close student on this phase of the profession.

The seven-day trip gave us many hours together, and to listen to his conversation was practically a seven-day course of lectures by a professor of practical marine engineering. Every question and problem that I could ask or advance he quickly stripped bare of its unessentials. Everything was discussed in practical man's talk, and in an entertaining way. He was indeed an exceptional fellow, for he took a keen pleasure in imparting his ideas, convictions and experience to others who might be helped by them.

I have felt that there is need of a word being said to some of the value of cultivating the willingness to listen to the suggestions and ideas of both the old men of the profession, and from your fellow engineers. This need is more vital to the young engineer. Let no enthusiastic, ambitious young engineer make little, or undervalue the lessons or value of experience that can be gleaned from an old engineer who may by chance want to talk to you of some of his younger days in the field. Polite and willing attention to what he may have to say need not obligate you to accept his conclusions, unless they coincide with facts and reasonable deductions therefrom.

Another thing that should be borne in mind is the fact that seldom are two different marine power plants identical, even though they may be on sister ships, and that practice which may apply to one may not apply to the other, therefore there may be good grounds for differences of opinion.

It is these personal contacts with old engineers of broad experience wherein lies a valuable source of information to anyone anxious to profit by such opportunities. The facts are all gathered on the first hand, as the result of personal experience, and in getting them this way there is generally some small bit of personality interwoven that always helps to deepen the impression, and when the time of need for its recall to mind is present it makes the remembrance more ready.

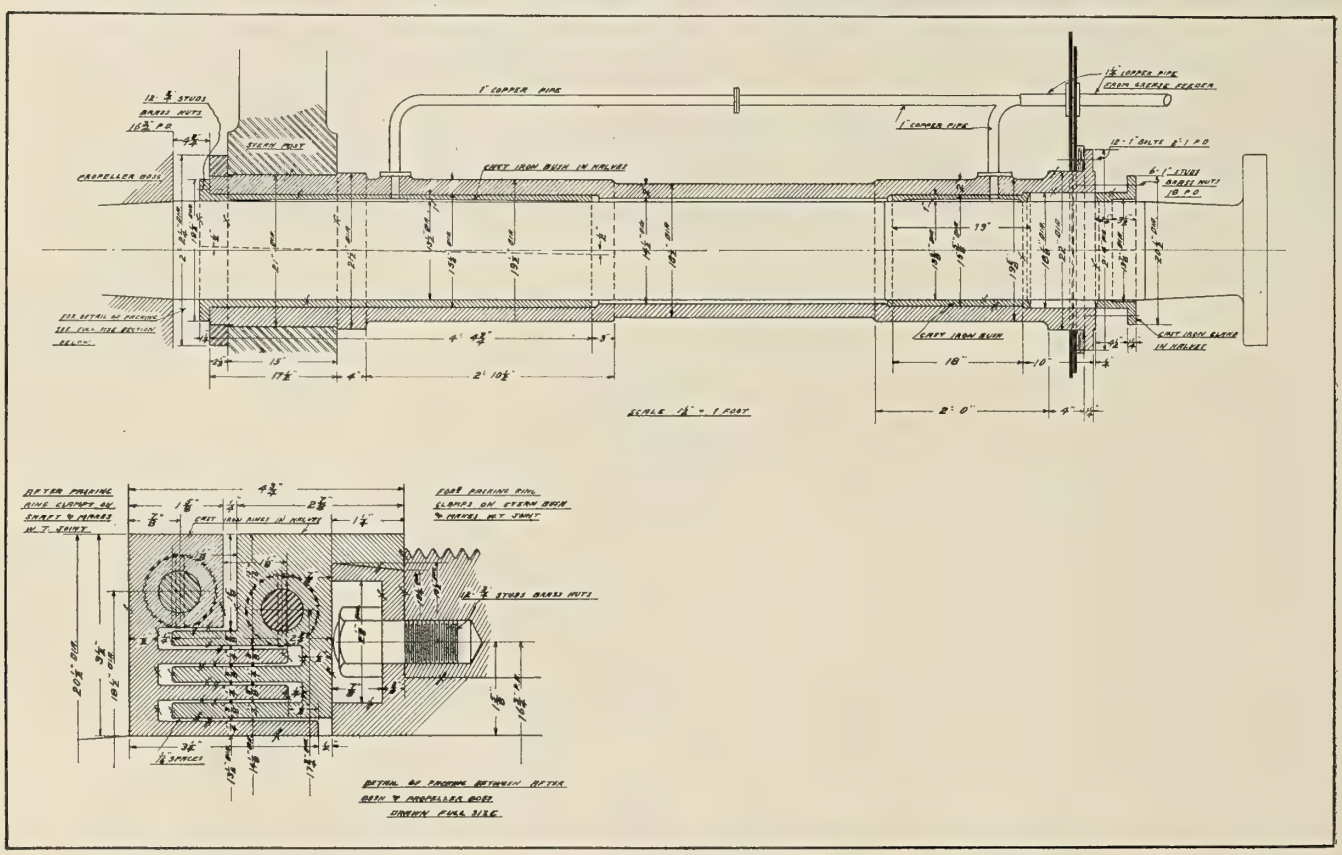
C. H. Willey.
Concord, N. H.

New Design of Stern Tube

A stern tube with its brass bushes lined with lignum-vitæ and its shaft cased its full length with a brass liner is undoubtedly a fine piece of work. But in these times of stress are we justified in using such a highly refined job? And besides, is this refinement necessary?

The illustration shows a tube and shaft designed to eliminate all brass parts except stud nuts. The shaft has, at both the tube and the boss. The grease working out the labyrinth passage will keep the water away from the shaft. Other styles of packing could be used; for instance, a pair of overlapping rings, forced apart by springs, one fixed to the tube and the other arranged to rotate with it, but allowed fore and aft motion to bring it against a bearing surface on the forward side of the boss.

Grease cups for lubricating a pair of tail shafts running



Stern Tube and Tail Shaft Without Brass Bushes or Liners for Triple-Expansion Engines With Cylinders 24 Inches, 38 Inches, 62 Inches by 42 Inches Working at 180 Pounds Pressure

of course, the proper allowance in diameter as required by Lloyd's rules for shafts without a continuous brass liner, viz., 21/20ths of the diameter with a continuous liner.

The shaft which this one would replace is 12 13/16 inches in diameter. It will be seen, therefore, that the increase is less than ¾ inch. As no brass liner has to be provided, a smaller outside diameter of stern tube is possible. The weight of the forging for the shaft will be slightly increased; but the shaft, ready to install, will be lighter. The tube, being smaller, will also be lighter.

The regular design of stern tube allows the sea water access to the interior of the tube and relies on the brass liner for protection from corrosion. How many shafts have been ruined because of a defective joint between sections of the liner, or between the liner and the propeller boss? The shaft shown is arranged to run in cast iron bushes, the length of which is such that bearing pressure is very light and wear will be exceedingly small.

Lubrication is provided for by a feeder operated by an eccentric on the tunnel shafting, forcing grease into the tube. The only way out for the grease is at the after end, and, as the recess of the tube would be filled before the shaft is inserted, entrance of water to the tube is prevented.

The labyrinth packing between the after end of the tube and the forward side of the boss makes a watertight joint in cast iron bushes were installed by the writer some years ago and the shafts are still in excellent condition, with no signs of the water having got to the shafts.

New Westminster, B. C. A. F. MENZIES,
Mechanical Engineer.

Harmony

In the planning of shop work there are many propositions upon which different men do not agree or think along the same lines, especially when the particular plan did not originate in their minds. Right here is a time when a fellow unwittingly shows his real make-up by his unwillingness to co-operate with the other fellow in working out the scheme. When a problem develops upon which two men think entirely different methods should be used, and both cannot have their way, it should be settled on an arbitrary basis, placing the interests of the business and harmony of the organization above personal desires for satisfaction of having one's own way.

Too many times do we witness the display of ill feeling by the defeated or disappointed one, as he ignores his duty in the whole plan, and deliberately evades assistance in working it through in the manner decided upon. But, if even by chance, he is obliged by necessity to take hold and aid in the work, he does so doggedly and half-heart-

edly, and really in his own heart hopes that the plan will be a failure—just because his was not used instead. Such a man is a detriment to any organization, even though he may be a skillful mechanic or a competent man at his work.

No man should allow his personal feelings to dominate his better judgment. There should not be a question of the moral right or wrong—it should always be rather a decision of the best interest of the shop's business.

How much more inspiring and pleasing it is to watch the other kind of a fellow, who co-operates with the plan decided upon, and does his very best to push it through to a successful conclusion. He must and does realize a personal feeling of satisfaction, even though he had to lay aside his own idea or plan in order to help the other fellow to succeed. It goes without saying that such a man is a valuable asset to the organization.

SUPERINTENDENT.

Crank Pin Repair

While on watch one night I observed the low pressure crank pin move down when on the top center and move up when on the bottom center. Not wishing to disturb the engine-room staff, I decided to keep it under close observation to make sure before taking any drastic action.

After satisfying myself that things were as they should not be, I decided to call the chief. After he arrived in the engine room and had had a look at the crank pin he decided not to take any action until we were nearer port. He consulted with the captain, however, and they agreed to run the engines at half speed and to make for the nearest port.

After two more days' steaming we arrived at port, and the third engineer and myself, with some of the firemen, began dismantling the low pressure engine by disconnecting the connecting rod from the crank pin while the chief and the second went ashore to secure the necessary gear. It was decided to carry out the repair in the following manner:

Our chief was fortunate in securing four good, strong ratchets, and we commenced drilling a series of holes half in the crank pin and half in the web. On the forward

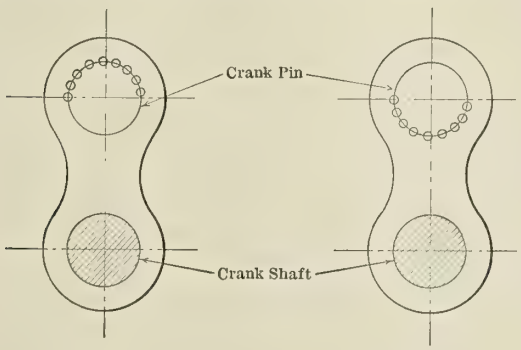


Fig. 1 Fig. 2

side of the crank we drilled the holes on the top side of the crank pin and on the after side we drilled the holes on the bottom side of the crank pin. We commenced drilling with a ⅞-inch twist drill, and after drilling to a depth of 4 inches we next started with a 1¼-inch twist drill to the above depth, and after finishing with this size we completed the drilling with a 1⅝-inch drill.

Afterward we finished reaming out the holes so as to have a smooth finished hole to be ready for the dowel pins, which the chief had ordered from a repair shop near by. The pins were made a good driving fit, and, after giving them a good coating of oil and a few friendly taps with our Monday hammer, they were soon driven home.

The connecting rod was coupled up and soon all was got ready for a trial, which, under easy steam, was a success. It was decided, however, to keep going under easy steam for a couple of days, and, after the expiration of that time, we stopped and had an inspection, and were delighted to find our job a success.

Figs. 1 and 2 will explain the arrangement of the dowel pins. The reason why we put the pins on the top side of crank pin on the forward side and on the bottom side on the after side was to prevent any undue strain on the crank pin. By driving the pins well home they have the tendency to swell the crank pin out against the web, thus making it a good, tight job.

ANDREW LAN.

Enfield, Sydney, N. S. W.

Shaft Repair

The shaft of one of our blower engines broke between the fan casing and the engine bearing. To remove this shaft and make repairs would have required disabling the blower for several days, and to make any temporary repairs seemed almost out of the question, but, luckily, one of our engineers saved the day by his resourcefulness. Figs. 1 and 2 show the manner in which a clever repair was made.

With the aid of an air hammer and chisel, the shaft was dressed up at the break, as shown in Fig. 1. Two

Fig. 1.—Broken Shaft Dressed, Ready for Babbit Coupling

flats were made to take care of the driving torque, while the dovetails, cut as shown, kept the break from separating; in other words, these acted as anchors. After the shaft was dressed as mentioned, a mold was made around

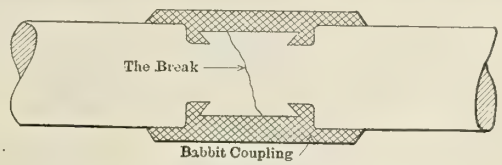


Fig. 2.—Section Through Babbit Coupling

it out of sheet tin to form the babbit coupling. The completed job is shown in Fig. 2.

This, while being a unique repair, has given very satisfactory service, for the babbit coupling was reinforced by forming up a circular sheet steel band, not shown in the sketch. The machine is still doing service today. It is thought by the writer that this repair will be found handy to others.

MACHINIST'S MATE.

CORRECTION.—In the article, "Notes on Rudders," page 445 of our October issue, equation (1), which reads

$$P = 1.622 \frac{\sin\theta}{0.39 + 0.61 \sin\theta} - \frac{w}{2g} A V^2$$

should read as follows:

$$P = 1.622 \frac{\sin\theta}{0.39 + 0.61 \sin\theta} \times \frac{w}{2g} A V^2$$

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Relative Efficiency of Engines

Q. (917).—The following question was offered on a recent college examination paper. Will you please work out the solution for me?

"Three triple expansion engines designed for 150 pounds throttle pressure and 2 pounds back pressure are of identical dimensions and construction. One was purchased by 'A' and installed to operate with steam 2 percent priming at a throttle pressure of 200 pounds and a back pressure of 21 pounds. Actual tests showed that it had a steam consumption of 14.8 pounds per indicated horsepower per hour.

"The second engine was purchased by 'B,' installed to operate between 100 pounds throttle and 1½-inch back pressure with steam dry saturated at the throttle. The actual steam consumption was 15.0 pounds.

"The third one was purchased by 'C,' operated at 140 pounds throttle with 40 degrees superheat and a back pressure of 2 pounds. Its measured steam consumption was 14.6 pounds.

"Which man got the best engine?

"Which man got the poorest engine?

"How much better was the best than the poorest? Express in percentage."

A. (917).—The amount which each engine produces as a percentage of that possible is given by the ratio of

$$\frac{\text{Ideal (Rankine Cycle) steam consumption}}{\text{Actual steam consumption}}$$

sometimes called the commercial efficiency, and expressed as

$$\text{Commer'l efficiency} = \frac{2{,}545}{(H_1 - H_2) \times \text{actual steam consumption}}$$

where H_1 is the heat content at the admission point, H_2 is the heat content at the exhaust point, and the steam consumption is expressed in pounds per horsepower per hour.

For the three engines the commercial efficiencies are:

$$A = \frac{2{,}545}{(1{,}180 - 881) \times 14.8} = 57.6 \text{ percent.}$$

$$B = \frac{2{,}545}{(1{,}186 - 916) \times 15.0} = 62.7 \text{ percent.}$$

$$C = \frac{2{,}545}{(1{,}217 - 926) \times 14.6} = 60.0 \text{ percent.}$$

It is fair to assume that if these engines were to operate at different ranges their commercial efficiencies would not change appreciably, therefore if B were put in place of A it would produce 62.7 percent of the energy available, and therefore be better than A, which only produced 57.6 percent.

The best engine is B, the poorest engine is A, and B is better than A by

$$\frac{62.7 - 57.6}{57.6} = .089, \text{ or nearly 9 percent.}$$

The problem could also be solved by adjusting the consumption to a uniform Rankine cycle, say that of engine C, as follows:

Rankine efficiency of A (from chart published in INTERNATIONAL MARINE ENGINEERING, June, 1917) is 27.3 percent; of B, 24.7 percent; of C is 25.5 percent. Adjusting the actual steam consumptions to those of engine C, the corrected steam consumption would be:

$$A = 14.8 \times \frac{.273}{.255} = 15.85 \text{ pounds per horsepower per hour,}$$

$$B = 15.0 \times \frac{.247}{.255} = 14.55 \text{ pounds per horsepower per hour,}$$

$$C = 14.6 \times \frac{.255}{.255} = 14.6 \text{ pounds per horsepower per hour,}$$

if all worked on the same range as C. From which it will be observed that B got the best engine, A the poorest, and B's was better than A's by

$$\frac{15.85 - 14.55}{14.55} = \frac{1.3}{14.55} = .089, \text{ or about 9 percent.}$$

Strength of Boiler After Pitting

Q. (916).—I have some B. & W. boilers of the Aultman-Taylor land type which, some time ago, became rather badly pitted along the steam drums where the feed entered. The pitting was stopped, however, and has not appreciably increased in the past several years. We have been operating at 125 pounds, and now, owing to press of work, it is desirable to increase the working pressure to 150 pounds, which was what the boilers were originally designed to operate at and did operate at. The drums are of 15/32-inch plate, 42 inches diameter, 20 feet length, with two longitudinal seams, double riveted, with ⅞-inch rivets, 3-inch pitch and 2-inch back pitch (distance between rows). The pitting is pronounced and continues along the length of the drums just under the feed entrance. For the first 6 feet it is deepest and has in the worst case an average depth of somewhat less than 0.10 inch. In addition to this there are local patches of pitting at various intervals over the lower half of the drums. That first noted is the worst, however. The question has arisen as to the advisability of operating this unit at the 150-pound pressure desired. Will you please give me your opinion as to whether it is safe to do this or not?

A. (916).—If we assume that the pitting has a uniform depth of 0.10 inch and extends the entire length of the drum, the strength along this line of weakness will be about 78 percent of the strength of the intact plate. The efficiency of the riveted longitudinal seam as figured below is approximately 65 percent of the intact plate, so that the pitting has not weakened the drum to an extent greater than the weakest point of its normal structure.

It needs careful watching, however, in future use and will eventually have to be renewed.

The computations follow:

Double Riveted Seam Lap

Plate now about 15/32 inch thick.

Rivets ⅞ inch diameter, 3 inches pitch, 2 inches back pitch.

a = area of rivet, square inches.
P = pitch in inches.
t = thickness of plate, inches.
d = diameter of rivet.
S = shearing strength per square inch.

(A) Strength of intact plate = $P \times t \times 55{,}000 = 3 \times .469 \times 55{,}000 = 77{,}500$ pounds.

(B) Strength of plate between rivet holes = $(P - d)t \times 55{,}000 = 2.13 \times .469 \times 55{,}000 = 55{,}100$ pounds.

(C) Shearing strength of two rivets in single shear = $2 \times S \times a = 2 \times 42{,}000 \times .601 = 50{,}500$ pounds.

(D) Crushing strength of plate in front of two rivets = $2d \times t \times 95{,}000 = 2 \times .875 \times .469 \times 95{,}000 = 77{,}800$ pounds.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

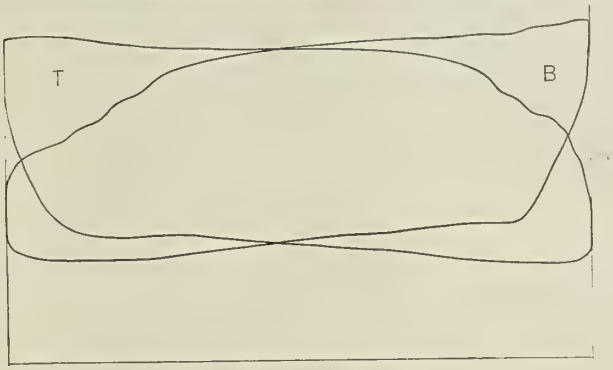
$$\text{Efficiency of riveted joint} = \frac{C}{A} = \frac{50{,}500}{77{,}500} = 65 \text{ percent.}$$

If pitting were uniform in depth of 0.10 inch, the strength along this line would be .369/.469 of the intact plate, or 78½ percent.

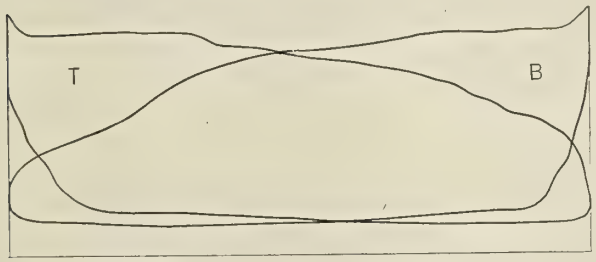
Indicator Cards Analyzed

Q. (902).—Please analyze inclosed indicator cards. Cylinder, diameters: High pressure, 12 inches; intermediate pressure, 20 inches; low pressure, 34 inches. Stroke, 24 inches. Diameter of piston rod, 3 inches. Revolutions per minute, 145.5. Boiler gage, 171 pounds; intermediate receiver gage, 57 pounds; low pressure receiver gage, 5 pounds; vacuum, 25 inches.

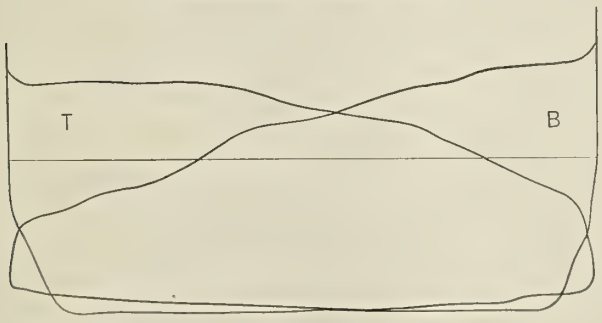
A. (902).—The detailed working up of the cards is given below. The cards themselves show room for but little improvement and the distribution of work is reasonable. There is probably little that can be gained by making any changes. A slightly better economy and distribution of effort would be obtained by operating at an increased boiler pressure (say 185 pounds) and shortening the cut-off in the high pressure cylinder.



High Pressure Card



Intermediate Pressure Card



Low Pressure Card

	Areas of Indicator Cards, Square Inches	Length of Cards, Inches	Mean Height, Inches
High Pressure:			
Top	3.81	3.5	1.088
Bottom	3.58	3.5	1.022
Intermediate Pressure:			
Top	3.14	3.49	.900
Bottom	3.10	3.49	.888
Low Pressure:			
Top	3.94	3.55	1.110
Bottom	3.65	3.55	1.028

	Mean Effective Pressure	Area Pistons, Square Inches
High Pressure:		
Top	87.04	113.1
Bottom	81.76	106.0
Intermediate Pressure:		
Top	36.00	314.2
Bottom	35.52	307.1
Low Pressure:		
Top	11.10	907.9
Bottom	10.28	900.8

Area 3-inch rod = 7.07 square inches.

$$\text{Factor} = \frac{2 \times 145.5}{33{,}000} = .008818$$

High Pressure:
Top = .008818 × 113.1 × 87.04 = 86.7
Bottom = .00882 × 106.0 × 81.76 = 76.5
Intermediate Pressure:
Top = .00882 × 314.2 × 36.00 = 99.7
Bottom = .00882 × 307.1 × 35.52 = 96.1
Low Pressure:
Top = .00882 × 907.9 × 11.10 = 88.8
Bottom = .00882 × 900.8 × 10.28 = 81.6

Total horsepower 529.4

Can Iron be Gasified?

Q. (905).—I have two questions to ask that I have heretofore been unable to have solved. (1) If it is possible to attain sufficiently high temperatures and pressures, can iron be gasified? (2) Is the center of the earth a large volume of gas?

A. (905).—The answer to question (1) is that iron has been distilled (in the gaseous state) in electric furnaces at about atmospheric pressure.

To question (2) no definite answer can be given, for nobody knows what the center of the earth consists of. Great pressure may produce liquefaction, but produces it more readily the less the temperature; the converse (gasification) is most readily obtained at high temperatures, and the less the pressure the better. For example, you can have highly superheated steam at atmospheric pressure and also can superheat steam at a high pressure, but the first condition requires less heat to produce it. If you are interested in obtaining a gaseous state from a solid state, you will accomplish it most readily at the lowest pressure at which you can operate. It should be borne in mind, however, that our ordinary conception of what constitutes a gaseous state [that the molecules are separated from each other to such an extent that they tend to increase this distance (expand) indefinitely] does not hold when pressures are so enormous as to bring the molecules close enough together to be seriously affected by mutual attractions.

Power and Revolutions of Propelling Engines on Dock Trials

Q. (918).—With a turbine engine developing 22,000 horsepower, the wheel has a pitch of 100 inches, a diameter of 9 feet 2 inches, and makes 335 revolutions per minute. What would be the revolutions per minute if the ship was made fast to the dock and not allowed to move? Would the engine develop the same or more or less power under these conditions, assuming the pressure on the steam chest to be the same as when under way.

A. (918).—The power quoted is abnormal for a single shaft and propeller of the dimensions given and is probably divided among several shafts, though the data give no hint of it. Assuming such to be the case, it is probable that in the original design the propellers were calculated so as to operate close to the point of cavitation and any large increase in tip speed or slip will undoubtedly produce cavitation. If cavitation results, the power at the same revolutions per minute will be less than in normal running. What the revolutions per minute will be for the same boiler pressure under this condition cannot be predicted, but they will be much greater. The horsepower would probably be less.

Correction.—The answer to Q. (903) in the September number, page 415, relative to the movement of a valve, if the eccentric with 5-inch throw on a 15-inch shaft is moved ⅛ inch, was based on the assumption that the center of the eccentric moved ⅛ inch. In shop practice this measurement would be made on the periphery of the shaft, and since the ratio of eccentric throw to shaft diameter in this case is 1 to 3 the valve movement would be 1/24 inch and not ⅛ inch maximum, as stated.

FIRST BRITISH STANDARDIZED CARGO SHIP

Photographs Reproduced from "The Engineer," London

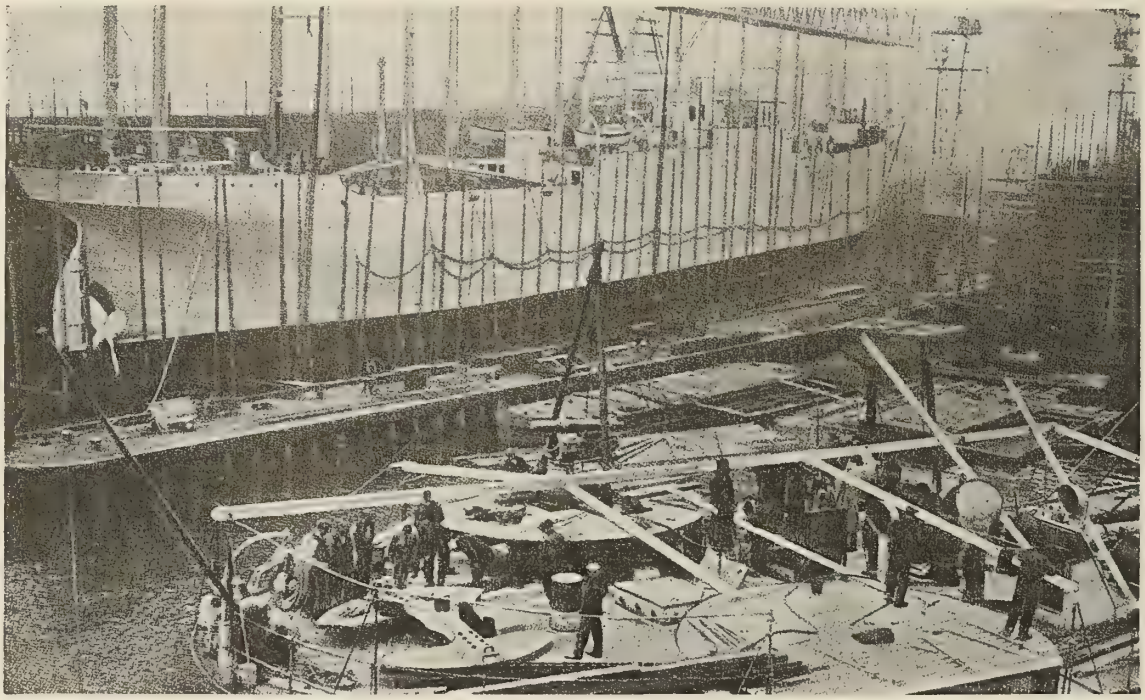


Fig. 1.—Standard Ship of 8,000 Tons Deadweight Carrying Capacity About to Be Launched, With Stern of a Sister Ship in the Foreground

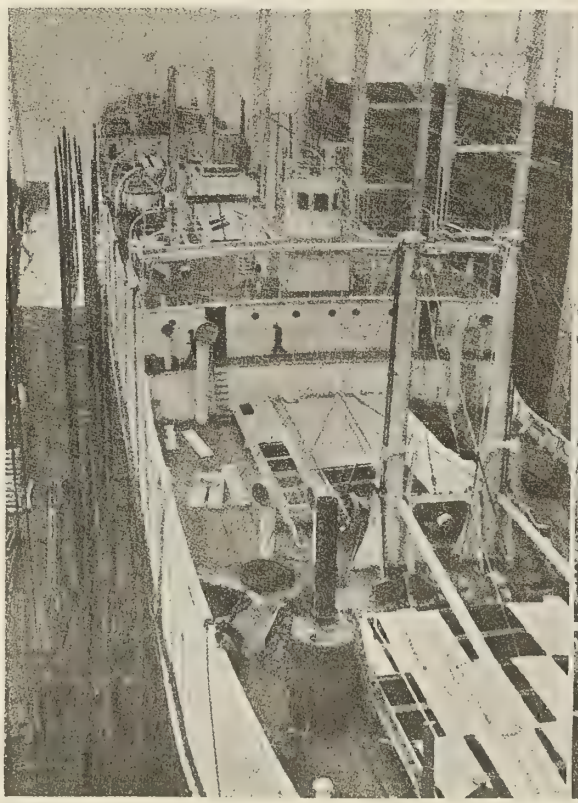


Fig. 2.—Deck View of Ship Ready for Launching

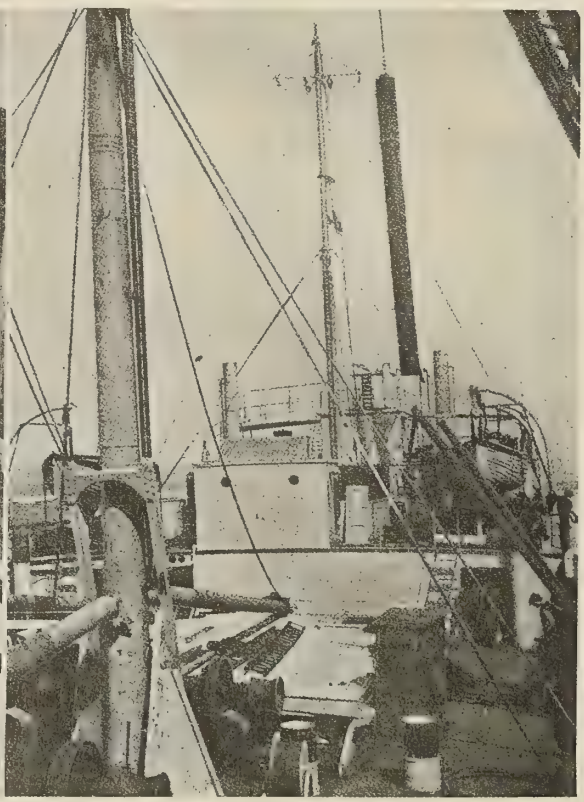


Fig. 3.—Fitting Out the Vessel for Sea Service

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

BETHLEHEM STEEL SHIPYARDS CONSOLIDATED

Six of the Largest Shipyards in the United States Under Management of Bethlehem Shipbuilding Company

The Bethlehem Steel Corporation, which controls six of the largest shipyards in the United States, including the Fore River Shipbuilding Corporation, Quincy, Mass.; the Harlan & Hollingsworth Corporation, Wilmington, Del.; the Samuel L. Moore & Sons Corporation, Elizabeth, N. J.; the Union Iron Works Company, and the Union Iron Works Dry Docks Company, San Francisco, Cal., and the Bethlehem Steel Shipyard at Sparrows Point, Md., has organized the Bethlehem Shipbuilding Company, capitalized at $12,500,000, with headquarters at South Bethlehem, Pa., to have complete charge of all its shipbuilding interests.

E. G. Grace, head of the Bethlehem Steel Corporation, is president of the new shipbuilding company; Joseph W. Powell, president of the Fore River Shipbuilding Corporation, has been appointed vice-president and executive head, and H. S. Snyder, vice-president of the Bethlehem Steel Company, has been made vice-president, in charge of finances of both the shipbuilding company and the steel corporation. The other officers include H. E. Lewis, vice-president; E. B. Hill, treasurer; B. H. Jones, secretary; F. A. Shick, comptroller; William M. Tobias, purchasing agent, and J. M. Gross, general traffic manager.

Mr. Powell has taken active charge of the sales and operations of the new company at South Bethlehem, and with him are associated several other officers of the Fore River Shipbuilding Corporation, including Vice-President and General Manager H. G. Smith, Vice-President Harry Brown, Treasurer E. B. Hill, and Joseph Larkin of the service department. S. W. Wakeman, formerly general superintendent of the Fore River plant, succeeds Mr. Powell at that plant with the title of manager, and Joseph P. Kennedy, formerly president of the Columbia Trust Company, Boston, has been appointed assistant manager.

The formation of the Bethlehem Shipbuilding Company was brought about after the consultation with the Navy Department for the purpose of speeding up the construction of ships. According to the formal announcement, the demands of the Government on the facilities of the shipbuilding plants will make it essential that all duplications of engineering and similar overhead work shall be avoided so far as is possible, and the proposed consolidation is expected, through the resulting standardization and the centralization of management, to increase the production of the yards affected—a result of vital importance in this time of insistent demand for expedition in the building of ships.

There will be no radical departure from the present operating methods at the individual yards, except that the sales, purchases, accounting, collections and payments for all shipbuilding operations will hereafter be made or done at or from Bethlehem.

Pacific Coast Now Represented on the Shipping Board

Charles R. Page, the new member of the United States Shipping Board, is a son of the late Charles Page, of San Francisco, Cal. Mr. Page is a graduate of Yale University, and has been connected with the shipping industry with Hind, Rolph & Company, of San Francisco, and more recently with the Fireman's Fund Insurance Company.

Mr. Page takes the place on the Shipping Board of Mr. Theodore Brent, of New Orleans, who resigned with Mr. Denman, former chairman, and before coming to Washington made an extensive investigation of the Pacific Coast shipyards.

The Shipping Board is now composed of the following: Edward N. Hurley, Chicago, chairman; Raymond B. Stevens, New Hampshire, vice-chairman; John A. Donald, New York; Bainbridge Colby, New York, and Charles R. Page, San Francisco.

President of Munson Steamship Line Joins Exports Administrative Board

Frank C. Munson, president of the Munson Steamship Line, has been appointed a member of the Exports Administrative Board. The other members of the Board are: Vance McCormick, chairman, representing the Department of State; J. B. White, representing the Food Controller; Thomas Jones, representing the Department of Commerce, and Dr. Taylor, representing the Department of Agriculture.

For twenty-two years Mr. Munson has been connected with the Munson Line. He is also prominent in civic affairs connected with shipping interests, having been for several years on the Mayor's Port and Terminal Committee and chairman of the Brooklyn Committee on Waterfront and Terminal Railroads, a member of the board of managers of the American Bureau of Shipping and a member of the American Committee of Lloyd's Register of Shipping.

NAVAL WAR CONSTRUCTION NOW COMPRISES 787 VESSELS, TO COST ABOUT $1,150,400,000

Destroyers Form Major Part of Programme

Five Yards to Build the Additional Destroyers

The war construction programme of the United States Navy now comprises 787 vessels, including all types, from superdreadnoughts to submarine chasers. Some of these have been completed in the past few weeks and are now in service. The rest of the programme is being pushed to completion. The total cost is estimated at $1,150,400,000.

Secretary Daniels has announced that arrangements have been completed for the building of the large number of additional destroyers planned, which will cost about $350,000,000. The Secretary said:

"These destroyers will be built by five companies which have had experience in building this type—the Fore River Shipbuilding Corporation, Boston; the New York Shipbuilding Corporation, Camden, N. J.; Cramps Shipyard, Philadelphia; the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., and the Union Iron Works, San Francisco.

New Plants Required

"This is the biggest project we have ever undertaken. Three months ago it looked as if it could not be done. Orders had already been given for all the destroyers the yards could build, and almost as many as the new programme calls for are now under construction or contract. To build rapidly the additional destroyers require a great extension of shipbuilding facilities and the erection of new plants for building engines. The companies were unwilling to invest millions in these additions, so the Government must build and will own the new plants and extensions which will be used by the builders.

"We are putting every energy and facility behind this project. Some of the new destroyers are promised for delivery in nine months, all within eighteen months. These vessels will be of the latest and largest improved type, which has just been tried in our service and found to be unsurpassed by any destroyers in the world.

Advantage of Uniform Type

"The plans are all ready, and the adoption of a uniform type will enable us to reduce the number of types of engines and parts and to turn them out in much less time. The principal trouble is in getting forgings and auxiliaries,

but the manufacture of these has been arranged for, and we will make every effort to prevent delay in delivery of materials or machinery.

"Thousands of men will be required to man these destroyers, and we are now busy training them. By the time the vessels are completed the crews will be ready. The spirit of the men in the navy—officers and enlisted men—is such that the destroyer service appeals to them, and many more than enough to make up the complements apply for service in this type of ship, which is the best weapon afloat against the submarine menace."

Shipbuilders Awarded Contracts for New Vessels

A contract has been awarded to the McAteer Shipbuilding Company and the National Steel Construction Company, jointly, for the construction of a 1,200-ton deadweight steel vessel for the United States Government, the contract being awarded by the Western Division of the Quartermaster Department.

The new vessel will be 170 feet in length, with a beam of 30 feet and a molded depth of 15 feet. The contract price is said to be about $250,000.

The Francis Cobb Company, Rockland, Me., will build a 3,500-ton freight ship for the Great Northern Paper Company.

The Wilmington Shipbuilding & Marine Construction Company, Wilmington, N. C., will build two four-masted wooden auxiliary schooners from the designs of Cox & Stevens, 15 William street, New York.

The new Elliott Bay Shipbuilding Company, of Seattle, President C. O. Morrow, has signed contracts for five full-powered, ocean-going, wooden motor ships for American interests, and work will be commenced immediately, as it is intended to have the five vessels under construction in the plant at the same time. The first two vessels are for interests engaged in the salmon canning industry in Alaska, and they will operate between Seattle and the North. The other vessels are to be built for Atlantic interests. The contracts call for motor ships 260 feet long, 46 feet wide and 26 feet deep, with a cargo capacity of 3,000 tons deadweight. Each of the motor ships will be supplied with two 500 brake-horsepower Diesel engines, which it is expected will give the vessels a speed of 9 knots.

SHIPBUILDING AT JACKSONVILLE, FLA.

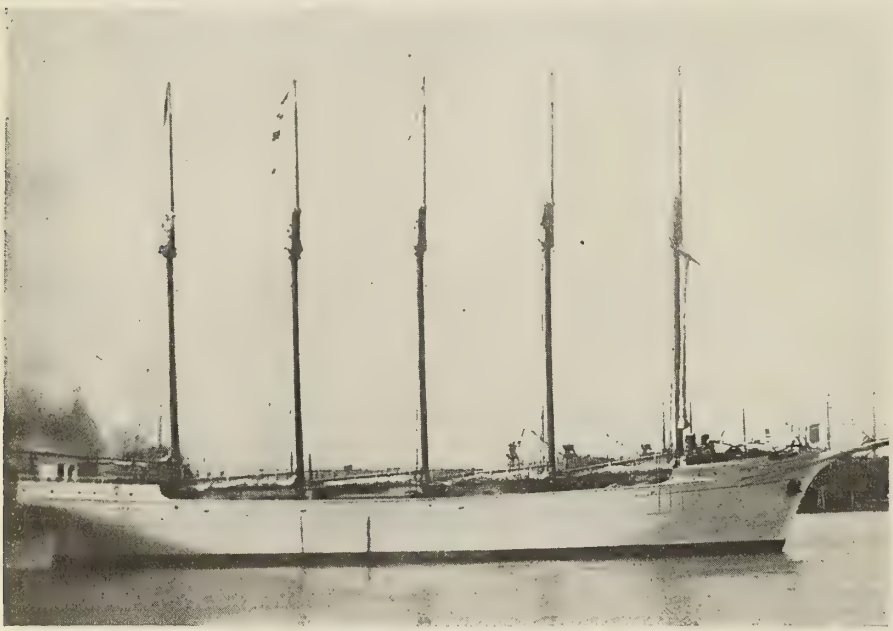
Available Water Frontage Given Over to Shipbuilding

Every available foot of ground on the Jacksonville side of the St. Johns River is now being used for the construction of ships, and much of the best water frontage on the South Jacksonville side is also occupied or held under lease by prospective shipbuilding concerns.

The new Merrill-Stevens plant, covering 60 acres of land directly across the river from the main plant, is nearing completion, and will represent an expenditure of over $500,000 before a keel is even laid. This concern dredged a slip 175 feet wide by 1,000 feet in length, and will launch their ships sidewise, as well as by stem and stern, into the river, thereby giving a capacity of twelve wooden or eight large steel or composite ships at one time.

The Government plant, formerly that of Hillyer-Sperring-Dunn, is installing a mammoth transformer, having secured electricity from the municipal electric plant of Jacksonville, and as soon as the additional machinery is ready the keels of several new vessls will be laid.

The plants now in active operation are Merrill-Stevens Company, G. S. Baxter Shipyards, Florida Shipbuilding Corporation, Gibbs Gas Engine & Shipbuilding Company, J. M. Murdock, Morey & Thomas, Florida Marine Construction Company, Hillyer-Sperring-Dunn Company (Government-operated).



(Photograph copyright by Press Illustrating Service, N. Y.)

Largest Sailing Vessel on the Pacific, the *Falketind* (formerly *Flagstaff*), of 4,000 Tons Deadweight Carrying Capacity

Terry Shipbuilding Company to Build Homes for Its Employees

The Terry Shipbuilding Company, which is constructing twenty steel cargo vessels for the Emergency Fleet Corporation, to be worth $20,000,000 in all, has closed a contract with the Port Wentworth Terminal Corporation at Savannah covering the erection of dwellings for its employees. The Terminal company is to erect houses as they are needed and lease them to the Terry corporation at a rental based upon the cost of construction.

The new buildings will become part of Port Wentworth City, which is being built to provide homes for employees of the various industries located at the terminal. The Terry plant alone will have over 3,000 workers.

Marine Terminal Improvements

The New York Dock Company, 44 Whitehall street, New York, has awarded a contract for the erection of a three-story reinforced concrete building, about 53 by 153 feet, on property recently acquired on Furman street, Brooklyn.

The Great Lakes Dredge Company, Port Arthur, Ont., has been awarded the contract for the construction of wharves and slips in connection with the steel plant to be erected for the Canadian Steel Corporation, Ojibway, Ont. The Canadian Steel Corporation is a subsidiary of the United States Steel Corporation.

P. B. Church & Company, Arcade building, Seattle, Wash., has received a contract to build a dock at Duwamish Waterway.

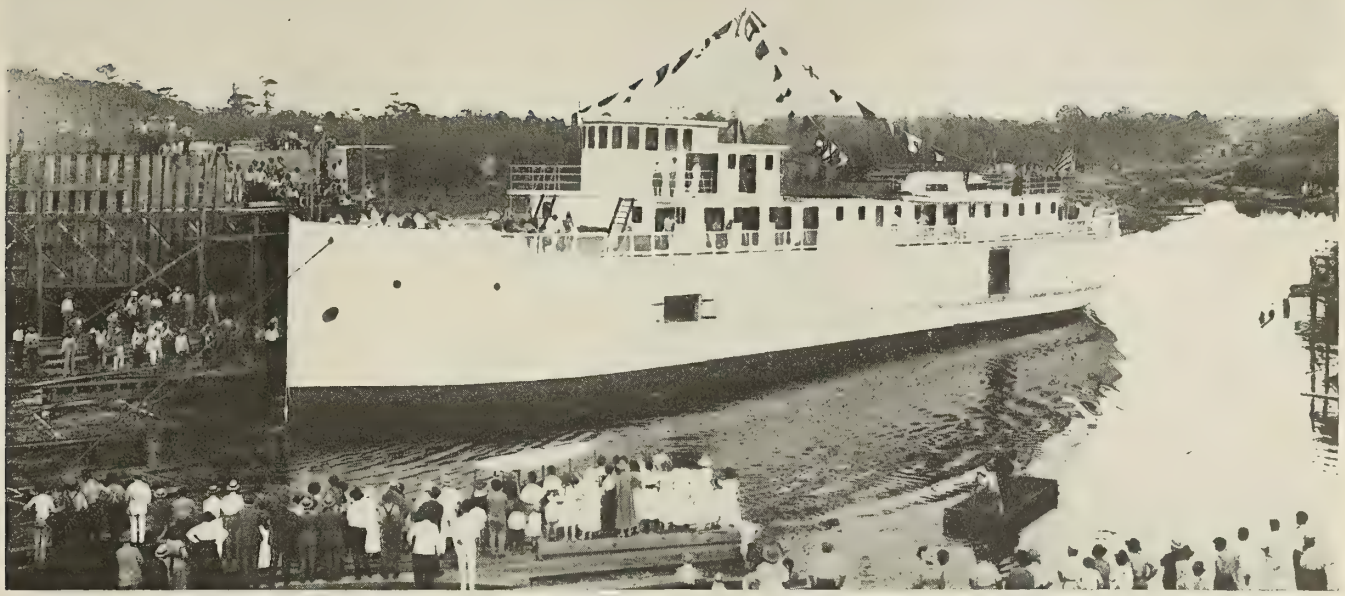
American Shipbuilding Company's Output

At the annual meeting of the American Shipbuilding Company, of Cleveland, Ohio, recently held in Jersey City, N. J., Mr. M. E. Farr, president of the company, said:

"During the current fiscal year thirty-one ships, with a total capacity of about 161,000 gross tons, have been completed and delivered to owners. There are now forty-three ships, with a total carrying capacity of about 160,000 gross tons, under contract.

"During the year appropriations for additional buildings, equipments and other improvements amounting to $1,063,000 were authorized. There was expended $15,000 for lands adjoining the Lorain plant, and $555,778 for buildings, equipment and other improvements. These additions have materially improved the efficiency of the several plants.

"While the net earnings for the year are satisfactory, they do not represent the maximum earning capacity of your company. A considerable part of the earnings of the current year came through the early and advantageous purchase of material. The scarcity of labor and materials, unusually bad weather conditions, embargoes, rising costs and other contingencies have prevented the management from obtaining maximum results. Conditions are better than at any time in the past, and the prospects for future business are favorable."



Launching of Passenger and Freight Steamer *Maple*, Built of Southern Pine at Slidell, La.

AMERICAN VESSELS OF 2,500 TONS CAPACITY OR OVER REQUISITIONED

Government Controls Ocean-Going Merchant Marine

The United States Shipping Board hereby has given notice to all owners of ships registered and enrolled under the laws of the United States that the requisition of all American steamers described below, and of which previous announcement has been made, became operative and effective on October 15, 1917, at noon.

1. The ships affected by said requisition and included therein are:

(*a*) All cargo ships able to carry not less than 2,500 tons total deadweight, including bunkers, water and stores.

(*b*) All passenger steamers of not less than 2,500 tons gross register.

2. (*a*) As to all steamers in or bound to American ports on October 15, 1917, requisition becomes effective after discharge of inward cargo and ship is put in ordinary good condition.

(*b*) As to steamers which have started to load their outward cargo requisition becomes effective at noon on October 15, 1917, and accounts as to hire and expenses will be adjusted from time steamer began to load.

3. Steamers trading to and from American ports that have sailed on their voyage prior to October 15, 1917, at noon, are to complete that voyage as promptly as possible and report for requisitioning.

4. Steamers that are occupied in trades between foreign ports shall be requisitioned as of October 15, 1917, at noon, and accounts adjusted accordingly.

5. (*a*) Owners whose steamers are operating in their regular trades are to continue the operation of their steamers for account of the Government, as they have been doing for themselves, until they receive further instructions.

(*b*) Owners whose steamers are chartered to others will apply to the Shipping Board for instructions regarding the future employment of said steamers.

(Signed) Bainbridge Colby,
Commissioner.

Coal for Neutral Vessels Regulated by the Government

The Exports Administrative Board of the United States, in formulating its policy with regard to granting bunkers to neutral vessels, are actuated solely by the desire to prevent commodities from going to border neutrals for export to Germany. At the present time the Exports Administrative Board will not permit commodities that may benefit the enemy, directly or indirectly, to be exported from this country to the border neutrals because the Board has not yet been able to elicit the information which will enable it to determine whether such commodities will so benefit the enemy; and in accordance with this policy the Board feels that consistency demands that it should not grant bunker licenses for a vessel which is bound for a border neutral and carries a cargo which may benefit the enemy, notwithstanding such cargo has originated in another country.

Restrictions on Cargoes

In other words, although the Board has no means, and does not purpose to prevent trade between other neutrals and the border neutrals, it is, nevertheless, in a position to state that if vessels wish to use the coal of the United States they should not be permitted to apply our coal to the prosecution of a voyage which will result in supplying or assisting to supply the enemy with foodstuffs or feedstuffs or any other commodities.

GOVERNMENT PLANT FOR BUILDING FABRICATED SHIPS BEGUN IN NEW JERSEY

Submarine Boat Corporation in Active Charge of the Plant

Fabricated Ships of 5,000 Tons to Be Built

Work has begun at Port Newark Terminal, on Newark Bay, N. J., on the second large Government plant for building fabricated steel ships. The plant is being built by the Submarine Boat Corporation, which is acting as agent for the United States Emergency Fleet Corporation. The yard occupies 125 acres, twenty-eight shipbuilding ways will be built and the yard will employ 12,000 men.

The site has a water frontage of 2,700 feet where the twenty-eight shipbuilding ways will be erected. On one side of the property is a slip 700 feet wide and a wharf 4,400 feet long by 50 feet wide. The buildings now being erected include an administration building 196 feet long, a hotel and restaurant 90 feet by 75 feet, two fabricating shops 360 feet long, a terminal building, a hospital, two garages, two principal storehouses for the fabricating plant, three paint storage buildings, a storehouse for heavy machinery 300 feet long, and a machine shop. Material will be handled throughout the yard by twenty locomotive cranes of from 15 to 25 tons capacity.

All machinery in the yard will be driven by electricity, which will be supplied by the Public Service Company. Fourteen electrically-driven air compressors will be installed, each of sufficient capacity to supply power for the air tools for two hulls.

D. H. Cox, of Cox & Stevens, naval architects, New York, and secretary of the Society of Naval Architects and Marine Engineers, is resident engineer in charge of operations at the plant.

NEW SHIPBUILDING COMPANIES ORGANIZED

Progress of Work in New Shipyards

The International Shipbuilding Company has been organized at St. Helens, Ore., to build wooden ships.

The Downey Shipbuilding Corporation, 120 Broadway, New York, which owns a shipyard at Milliken, S. I., N. Y., is making extensive enlargements to the plant.

The Union Timber & Products Company, Port Townsend, Wash., will build a wooden shipbuilding yard.

The St. John Shipbuilding Company, St. John, N. B., is preparing plans for a shipyard.

Carl Hartmann, Green Bay, Wis., of the Hartmann-Grenning Company, has organized a shipbuilding company to build a yard at Green Bay, for the construction and repair of steel and wooden vessels.

Walter E. Cabell, Cornelius C. Moore and Walter Curry, all of Providence, R. I., are reported to have secured a large waterfront at Portsmouth, R. I., where they are planning the construction of a shipyard and drydock.

The Coast Ship Company has been organized at Biloxi, Miss. It is reported that the company has already received contracts to build six wooden vessels. The officers are D. J. Gay, president; L. V. Pringle, vice-president, both of Biloxi, and W. A. McInnis, general manager, Gulfport, Miss.

The Henderson Shipbuilding Company has been organized at Mobile, Ala., by Frank Henderson and W. T. Henderson.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., has increased the capacity of its plant.

The Seaboard Barge Company has been organized in Monroe, N. Y., with a capital of $500,000.

The Baldwin Shipbuilding Company has been organized at New Baltimore, N. Y. S. & W. H. Baldwin, 30 Broad street, New York, are among the incorporators.

The Fort Mifflin Shipbuilding Company, which was organized in Philadelphia some time ago, with a capital stock of $10,000,000, is stated to have perfected plans for the construction of a shipbuilding plant on the Delaware River.

The Perry Motor Boat Company has been organized in Buffalo. N. Amigone and J. & P. Orlando, Buffalo, are the incorporators.

It is reported that the North Carolina Shipbuilding Company, Morehead City, N. C., will shortly erect a shipbuilding plant. It is said to have secured a Government contract to build several vessels.

The Gulf-Cuba Corporation has been organized in Apalachicola, Fla., to construct sea-going barges. S. E. Rice, Jr., is the president.

The Atlantic Coast Company, which bought the Townsend Marine Railway & Construction Company, East Boothbay, Me., is planning to build several large schooners.

The York River Shipbuilding Corporation, Mutual Building, Richmond, Va., is beginning the construction of its plant near West Point, Va.

L. H. Shattuck Company, which is building a shipyard at Newington, N. H., has received contracts to build more than a dozen steamers for the United States Shipping Board.

The Lilly-Fletcher Company has been organized at Los Angeles, Cal., to erect a shipbuilding plant. J. B. Lilly, of Los Angeles, is one of the incorporators.

The New York, San Francisco & Hong Kong Steamship Company, San Francisco, Cal., has bought 10 acres of land at Redwood City, with the reported purpose of erecting a shipbuilding plant.

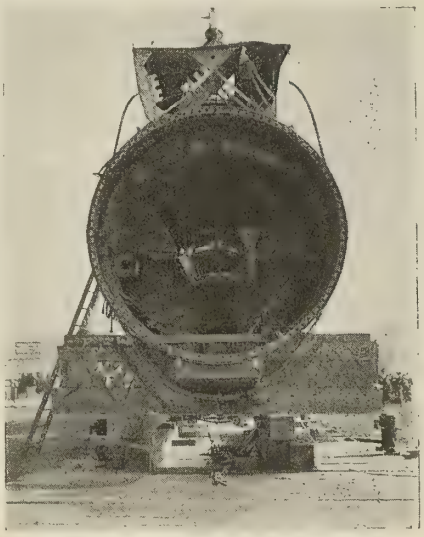
The Sommarstrom Shipbuilding Company has been organized in San Francisco, Cal., by M. F. Sommarstrom and others.

The Eastern Shore Shipbuilding Corporation, of which R. R. Livingston, 2 Rector street, New York, is president, has acquired a shipbuilding plant at Sparrows Point, Md., and will erect additional buildings, for which new equipment will be required.

One shipbuilding ways has been com-

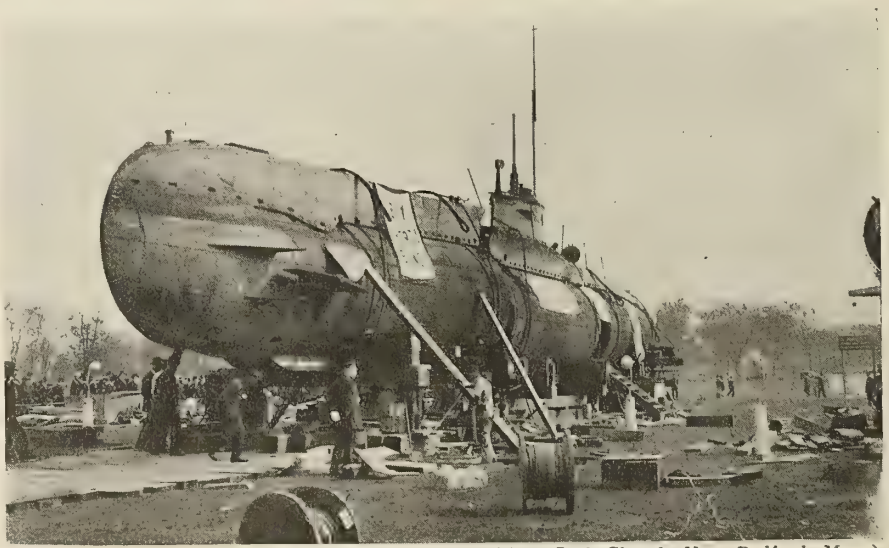
(Photograph by Albert Cook Church, New Bedford, Mass.)

Fig. 1.—Captured German Submarine, Exhibited at Central Park, New York



(Photograph by Albert Cook Church, New Bedford, Mass.)

Fig. 2.—Interior of German Submarine



(Photograph by Albert Cook Church, New Bedford, Mass.)

Fig. 3.—Bow View of Captured German Submarine

pleted by V. C. & J. E. Scott, of Mobile, Ala., for their shipyards announced last May. Five other ways will be added as needed, with facilities for constructing wooden vessels. A 100 by 50-foot building, of mill construction, with 25 by 20-foot boiler room, has also been completed and the machinery is in position. This machinery includes band-saws, planers, hoists, compressed air boring and hammering equipment. The plant is at Shellbank, on Chickasaw Bogue, near Mobile.

Seagoing barges and other vessels will be constructed at Apalachicola, Fla., by the Gulf-Cuba Corporation, which has been chartered, with $50,000 capital. A site has been secured and details are now being determined for the shipyards. It is reported that contracts amounting to $225,000 have already been secured.

The shipbuilding plant on the Niagara River, near Bridgeburg, Ont., which has been closed for several years, will soon be put in operation by the Canadian Allis-Chalmers Company, King and Simcoe streets, Toronto, the holding company of the Canada Foundry Company, Toronto, which has owned the plant for the past ten years. Steel ships of the size to pass through the Welland Canal will be constructed. A force of men will be put to work at once in order to get the yards ready for ship construction at an early date. The plant was constructed in 1903 by the now defunct Canadian Shipbuilding Company, and comprises about 200 acres. Some additional shipbuilding machinery will be purchased.

The Lake Erie Dry Dock & Engineering Company, Sandusky, Ohio, has been formed, with a capital stock of $11,600,000, to take over the plant of the Lake Erie Dry Dock & Mill Company, and probably other plants of that city. Chas. Bright and others are interested in the new company, which, it is stated, will engage in shipbuilding work.

The Pennsylvania Shipbuilding Corporation, Gloucester City, N. J., has increased its capital from $1,000,000 to $2,500,000.

Trained Navigators and Marine Engineers Graduated from New York State Nautical School

The forty-second commencement of the New York State Nautical School took place on October 13 on the recreation pier at the foot of 129th street, North River, New York, where the schoolship *Newport* is now berthed. Thirty-one cadets, nineteen in the deck and twelve in the engineering division, received diplomas, which were presented by Dr. John H. Finley, State Commissioner of Education. Certificates of graduation were presented by Captain George L. Norton, member of the Board of Governors of the school.

The officers of the *Newport* are Captain Felix Riesenberg, superintendent; C. E. Morgan, executive officer; Commander C. M. Matthews, U. S. N. (retired), chief engineer; Gershom Bradford, navigator; D. C. C. Craft, surgeon, and Junior Officer E. R. Glosten.

(Photograph by Edwin Levick.)

S. S. *Stian*, Second Vessel Launched by Standard Shipbuilding Corporation at Shooters Island, N. Y.

Sailing Vessels Barred from the War Zone

American sailing vessels have been prohibited from commerce in the war zone. The United States Shipping Board has instructed the Bureau of Export Licenses not to grant licenses for goods to be shipped through the war zone on sailing vessels.

Sailing vessel owners will have no difficulty, however, in chartering their vessels for voyages to South America, South Africa, in the coastwise trade or for other runs.

Personals

H. R. Alexander, president of the Pacific Steamship Company, has been elected a member of the Board of the American Steamship Association.

William A. Battey, Eastern sales manager and sales director of the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y., will sever his active connection with the business on December 1, but will retain his interest in the company and continue as a director. He will be succeeded by W. C. Briggs as district manager and Robert T. Turner as sales engineer.

Capt. William Matson, president of the Matson Navigation Company and Sweden's Consul-General, died recently in San Francisco.

John T. Heffernan, president and treasurer of the Heffernan Engine Works, Seattle, has been called to Washington for work in connection with the Shipping Board Emergency Fleet Corporation. Mr. Heffernan is associated with the American International Corporation, which owns the New York Shipbuilding Corporation, and is putting up the fabricated steel shipbuilding plant at Hog Island, Philadelphia.

Dr. Alexander Hamilton Rice, explorer, has been commissioned second lieutenant in the United States Naval Reserve force, and will become a member of the faculty at the cadets' school of the Second Naval District.

J. C. Craven, formerly in the hull estimating department of the Newport News Shipbuilding & Dry Dock Company, has been appointed naval architect with the United States Steel Corporation.

C. T. Putsell, formerly with the Newport News Shipbuilding & Dry Dock Company, has been appointed chief hull draftsman of the Amens Company, San Francisco, Cal.

H. G. House, formerly with the Skinner & Eddy Shipbuilding Corporation, Seattle, Wash., has been appointed naval architect of the Albina Engine & Machine Works, Portland, Ore.

C. W. Johnson, general superintendent of the East Pittsburg Works of the Westinghouse Electric & Manufacturing Company, has been elected vice-president of the American Institute of Metals.

Benjamin D. Fuller, of Cleveland, superintendent of foundries of the Westinghouse Electric & Manufacturing Company, has been elected president of the American Foundrymen's Association.

Edward O. Cutler, formerly assistant superintendent of the Bath Iron Works, Bath, Me., and more recently assistant manager of the Craig and California Shipbuilding Companies, Long Beach, Cal., is now assistant to the president of the Groton Iron Works, Groton, Conn., where a splendidly equipped new shipyard is being built for the construction of both wooden and steel vessels. The company now has contracts for twelve wooden steamers and six 9,000-ton steel steamers.

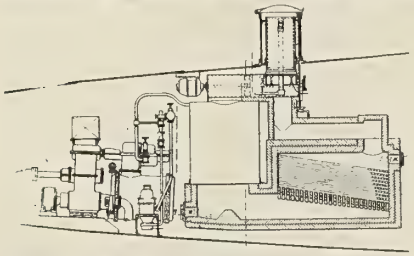
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,226,220. POWER-DEVELOPING APPARATUS. ALEXANDER T. KASLEY, OF SWISSVALE, PA., ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

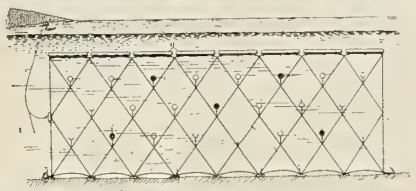
Claim 10.—In a power plant for submarines, a fluid pressure generator, a furnace having a combustion chamber in proximity with said generator, a second furnace having a com-



bustion chamber remote from said generator, a heat storing apparatus located between and forming a means of communication for said combustion chambers, a stack communicating with the off-take of said generator and serving both furnaces, means of communication between the off-take and said apparatus, and means for shutting off communication between the stack and the off-take and for establishing communication between the off-take and the apparatus for the purpose of delivering heat from the apparatus to the generator, and means for creating a continuous flow of heat carrying fluid, through the heat storing apparatus, the generator, the off-take and back to said apparatus. Fourteen claims.

1,226,348. SUBMARINE MINE AND PROPELLER ENTANGLEMENT. ARTHUR N. McGRAY, OF NEW YORK, N. Y.

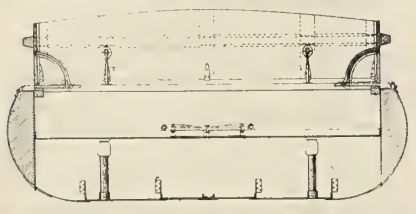
Claim 1.—A submarine defense comprising a plurality of looped propeller entanglements, an anchoring cable, and a connection extending from the bottom of each loop to the cable,



each loop having float means for co-operating with the cable to maintain the loops more or less upright, and the float means also serving to hold the loops open for entanglement with propellers, said loops being independent of each other and free to move laterally in all directions from the anchoring cable. Two claims.

1,226,944. LIFE BOAT AND THE LIKE. HARRY W. BROADY, OF BAYSIDE, N. Y., ASSIGNOR TO WELIN MARINE EQUIPMENT COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—A metallic nestable life-boat embodying a rigid shell having a well polygonal in conformation to permit immediate loading and a superstructure formed of rigid side and



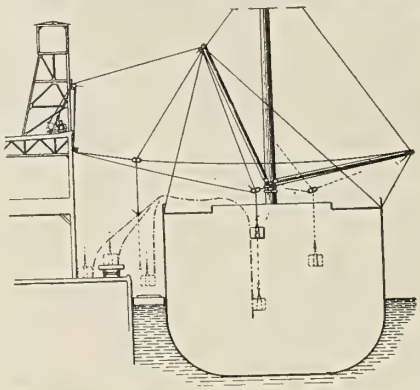
end members adapted to be raised and lowered relatively to the shell, means for automatically locking such side and end members when the same are moved into vertical position and an independent lock for alining the meeting edges of such side and end members and securely locking the same together. Two claims.

1,223,536. TORPEDO SHIELD FOR VESSELS. JOHN O. TRAVELSTEAD, OF PENDLETON, OREGON.

Claim 1.—The combination with a vessel, supporting means extending substantially longitudinally from the bow and stern ends of the vessel, shield members supported by said supporting means and laterally extending from opposite sides thereof for protecting the ends of the vessel, and other shields movably connected to the sides of the vessel and co-extensive therewith and having their ends connected to one of said laterally extending shields, said laterally extending shields being shiftable. Six claims.

1,228,344. LOAD-TRANSFER APPARATUS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J., AND LOUIS G. RUGGLES, OF NEW YORK, N. Y.; SAID RUGGLES ASSIGNOR OF HIS ONE-HALF TO LIDGERWOOD MANUFACTURING COMPANY, A CORPORATION OF NEW YORK.

Claim 10.—In a load-transfer apparatus, in combination, an elevated support, two hoisting ropes suspended from a common point on said support, a winding engine for each of said ropes, connections between said engines whereby said ropes may be taken up and paid out



simultaneously or independently of each other, a swinger frame engaging a fall of each of said ropes, and means for simultaneously swinging said frames in opposite directions to each other to swing said ropes laterally in opposite directions on said point of common support. Twelve claims.

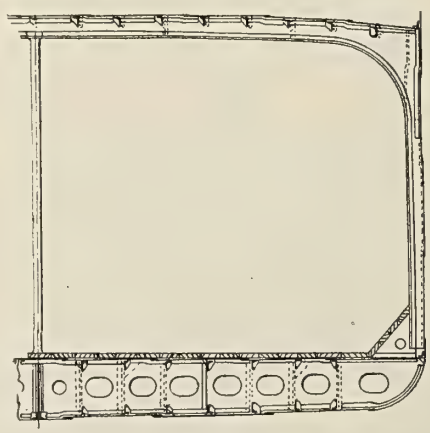
1,223,627. SHIP-PROTECTING SHIELD. WILLIAM A. SHEPHARD, OF WAUKESHA, WIS.

Claim 1.—A submersible shield for protecting ships comprising a frame, vertically disposed sheathing plates carried by the frame having their edges overlapped and spaced apart, arms having ends in hinged connection with the upper portion of the frame means for hingedly connecting the opposite ends of the arms to the sides of the vessel, and means for raising and lowering the shields. Two claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

106,124. "IMPROVEMENTS IN AND RELATING TO SHIPS' FRAMING." W. MILLAR, DIRECTOR OF THE GREENOCK AND GRANGEMOUTH DOCKYARD COMPANY, LTD., SHIPBUILDERS, GREENOCK, SCOTLAND.

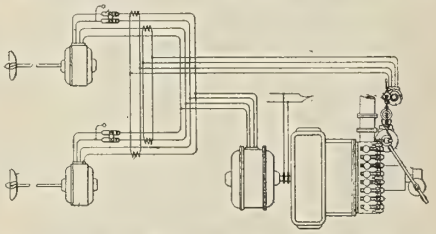
This invention relates to framing for ships, and it has for its object to provide an arrange-



ment or system adapted to give speedy erection and to save cost of labor and reduce the weight of material while providing without obstructions clear holds for cargo. It provides an improved system of the type in which transverse framing is combined with pillar beams and fore-and-aft stiffening for decks and bottoms of vessels. The vessel is built with ordinary side frames and with strong reinforced side frames, which are placed at suitable distances apart and are composed of any suitable sections, or may be of plate or lattice form. The reinforced frames are so constructed and arranged that they do not project into the hold of the ship. At the bottom thereof the ordinary frames and the reinforced frames are connected to the tank top with brackets and angles or the like or to the tank margin, as the case may be. Connected to each of the reinforced frames is a strong pillar beam slotted at suitable intervals to carry fore-and-aft stiffening sections forming the deck supports. The angles in these strong pillar beams are intercostal and are connected to the deck plating.

108,046. SYSTEMS OF SHIP PROPULSION. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, OF 83, CANNON STREET, LONDON, E. C., ELECTRICAL ENGINEERS AND MANUFACTURERS.

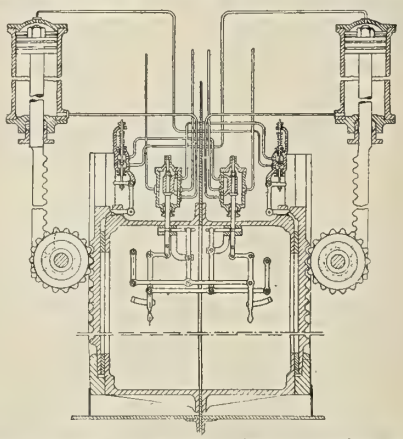
This system of electric ship propulsion comprises alternating current motors coupled to the shafts of propellers on each side of ship and



receiving current from a turbine-driven, alternating current generator and means for preventing an increased admission of motive fluid to the turbine to accommodate for any increase in load on either of the motors when the ship's motion is in the arc of a circle.

106,647. IMPROVEMENTS IN WATER-TIGHT DOORS FOR THE BULKHEADS OR PARTITIONS OF SHIPS, SUBMARINE VESSELS, CAISSONS, DIVING APPARATUS AND THE LIKE." ENGINEER LIEUTENANT I. TORO, CHILIAN NAVY, OF 22, WOLSELEY GARDENS, JESMOND, NEWCASTLE-ON-TYNE, IN THE COUNTY OF NORTHUMBERLAND.

This invention has for its object to provide a water-tight door for the bulkheads or partitions of ships, submarine vessels, caissons and the like to allow of persons easily making their escape from one compartment to an adjoining compartment without at any time allowing the watertightness of the bulkhead to be impaired, and thereby preventing water flowing through in sufficient quantity to endanger the safety of the vessel or the lives of the persons making



their escape. According to the invention, an opening is cut in the bulkhead, and to this opening is fitted, in a water and air-tight manner, a chamber or cell of rectangular or other suitable shape. This cell is formed by two rigid cast steel frames of the required dimensions, to enable one or more to move about in the cell. It has two openings, through which men can pass, and each of these openings is fitted with a sliding door adapted to slide in ways to and from the seat so that, when open, there is a clear entrance into the chamber, or when closed, a wedge-shaped edge on the doors enters between correspondingly shaped faces or into the recess in the seat or sill of the opening, thus forming a watertight joint to prevent leakage and render the doors self-packing. These doors can be operated hydraulically, pneumatically, electrically or otherwise in such a way that under no circumstance whatever can both be opened at the same time.

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Appoint a Shipbuilder to the Council of National Defense

SHIPBUILDING in the United States has become one of the most vital functions of the nation in forging its weapons for war. Under these conditions American shipbuilders are unanimously agreed that the industry which they represent should have a voice in shaping the war policies of the government through representation in the Council of National Defense. Other great war industries, such as munition making, coal mining and transportation, have been represented by recognized experts in the Council since its formation, and now that a petition has been sent to President Wilson by the Society of Naval Architects and Marine Engineers, urging the appointment of a representative builder of merchant vessels as a member of the Council, it is to be hoped that the shipbuilding industry may also receive its due recognition.

LIBRARY DEC 8 1917 PATENT OFFICE

Constructive Criticism

AT the naval architects' annual banquet, J. W. Powell, vice-president in charge of sales and operations of all the great shipyards owned and controlled by the Bethlehem Steel Company, clearly outlined the difficulties which are confronting American shipbuilders to-day. Not content with pointing out the difficulties, however, Mr. Powell went further and offered three valuable suggestions which, if followed, it is believed will go far towards overcoming these difficulties.

The first of these suggestions, which advised the appointment of a representative builder of merchant vessels on the Council of National Defense, was favorably received by the shipbuilders, and, as a result, the Society has petitioned the President of the United States to make such an appointment.

The second suggestion referred to the confusion and unsatisfactory relations which have existed between shipbuilders and the Emergency Fleet Corporation and which have hampered the progress of the shipbuilding programme. As a contrast to these conditions, Mr. Powell described the harmonious relations existing between the Navy Department and those shipbuilders who are engaged in naval construction, and suggested that shipbuilders and officials of the Emergency Fleet Corporation seek some common ground on which their differences could be reconciled and strive to co-operate more fully in carrying out their common purpose. The recent appointment of a board of five members representing the Atlantic Coast Shipbuilders' Association gives a splendid opportunity for smoothing out the numerous difficulties and misunderstandings between the Fleet Corporation and the shipyards and will permit the shipbuilders to spend more time at home building ships and less time in Washington at fruitless conferences.

The third suggestion, which perhaps is the most important of all, referred to the labor question. Mr. Powell suggested that a nation-wide campaign should be instituted to stimulate the loyalty and patriotism of labor. Shipyard workers, from the president down to the humblest employee, must realize that in this crisis shipbuilding is a service comparable in every respect to actual military service. Upon the efforts of the shipbuilders depend the lives of the men who are now being sent to fight in France, as well as the ultimate victory to our arms. Personal ambition and selfish motives must be swept aside and the same self-sacrificing spirit which dominates the men who are preparing to lay down their lives, if necessary, for the future peace and security of our country must guide the shipyard workers in their gigantic task.

What is actually being done to recruit and train shipyard labor is outlined in several articles printed elsewhere in this issue, but, as Mr. Powell says, a national campaign of personal education should immediately be undertaken to get labor in line for the ending of the war. To start such a campaign the Bethlehem Shipbuilding Corporation has offered to head a list to defray its expenses with a generous subscription. No time should be lost in carrying out this admirably conceived undertaking and prompt support should be forthcoming not only from shipbuilders, but from every patriotic American citizen as well.

Gossip from Washington

GOSSIP from Washington informs us that a foreign classification society has in its employ a representative—note we do not use the word lobbyist—to whom is paid a salary two or three times as large as is paid to the best technical men connected with the society. If this gossip is true, it seems as though an explanation should be made by the society in question. If the gossip is not true, it should be publicly and promptly refuted.

Whether it is or is not true, there is no possible excuse for the Shipping Board or the Emergency Fleet Corporation to permit vessels built of American steel, in American shipyards, and paid for in American money, to be "classed" by anybody except a distinctly American classification society. The American Bureau of Shipping is a decidedly patriotic and unselfish American organization. It is not an organization for money-making. Indeed, the shipbuilders, shipowners, underwriters and others backing it go down into their pockets each year for many thousands of dollars to meet necessary expenses.

Compare with this a foreign classification society, whose American representatives have little or no further authority than to send American plans and specifications, to say

nothing of American money, across the ocean. The money never comes back, but plans and specifications do, although in far too many instances they have been held back not only weeks, but months, to the great disadvantage of the American shipowners and shipbuilders. America can never have a merchant marine if it is to be held up in this way, as it has in many, many years gone by, by foreigners who are not at all anxious to help build up an American Merchant Marine.

Just after the gossip came from Washington, announcement was made that the Emergency Fleet Corporation had arranged for foreign classification of many vessels. No business man who is anxious to build up a permanent business would dare turn a large percentage of his orders over to a rival who had shown every inclination to prevent his succeeding. Why, then, should the United States Government do this?

The rules of the American Bureau of Shipping are, as a whole, more scientific, more up-to-date, and better adapted to American ship interests than any rules designed to suit conditions in some other country. Furthermore, the inspection service of the bureau is more prompt and efficient, and better suited to American conditions than any inspection controlled by strings or wires pulled from the other side of the ocean. There is every reason, therefore, why American-built ships should be classified by an American classification society and by no other.

Unjust Discrimination by the Shipping Board

IN a circular recently issued by the Shipping Board calling for tenders for the installation of machinery and the completion of wooden hulls now building in the Northwest for their account, which involves considerable dry dock work, it was stated that the Emergency Fleet Corporation does not favor the use of marine railways for this purpose. While objections to the docking of ships on some of the old-fashioned marine railways still in existence, which were built before sound engineering principles were applied to this class of marine construction, are undoubtedly just and well founded, nevertheless it is astounding that the construction department of the Emergency Fleet Corporation should discriminate entirely against the use of marine railways as a class. Modern railway dry docks are being widely used throughout the United States for the highest grade of work. One firm alone has built no less than 110 of these railway dry docks and they are being called for with increasing frequency from all over the world. The Navy Department is docking their largest destroyers and other vessels on these docks in different parts of the country, and is at present preparing to build several of them in the navy yards for docking vessels up to 350 feet in length. Modern railway dry docks are examples of some of the finest and most reliable engineering work that can be found, and any discrimination against their use by the Shipping Board can be accounted for only by complete ignorance of up-to-date dry dock engineering practice. This unjust discrimination should be promptly withdrawn by the Shipping Board, as under the present conditions every dry dock that is safe and properly designed is sorely needed.

An Ill-Advised Requirement

ONE of the regulations designed to reduce the visibility of merchant vessels, which is now under discussion by the Ship Protection Committee of the Shipping Board, provides that all steam vessels sailing from the United States for the war zone must carry a sufficient supply of anthracite coal to carry the vessel for not less than two daylight periods, and that this coal must be used during the daylight runs while within the war zone. While the purpose of this regulation is commendable, the results sought are not likely to be accomplished if the rule is put into force. In the first place an unlimited supply of anthracite coal is not available in many of the United States ports from which vessels are constantly sailing for the war zone, and in all probability difficulties will be experienced in furnishing an adequate supply for every vessel, especially in Southern ports, resulting in delays in sailings. Even if the supply of anthracite did not enter into the question there is a more serious disadvantage which must be faced, due to the fact that, on vessels with boilers operating on natural draft, anthracite cannot be burned at a sufficiently high rate to keep the vessel at her normal speed. On an American liner, for instance, the change from bituminous to anthracite coal reduced the speed of the vessel two knots. As speed is fully as essential as low visibility in escaping submarine attack, it would appear that whatever advantage would be gained in one direction would be offset by losses in another. Furthermore, the average fireroom crew lacks experience and skill in burning anthracite coal, and this factor will undoubtedly have an adverse effect on the steaming power of the vessel. In all probability better results would be obtained by more careful training of the firemen in the smokeless combustion of bituminous coal, for under careful supervision and with proper conditions in the furnaces the production of smoke can be greatly lessened and at the same time full speed maintained.

The Future of Tank Ship Construction

A SERIOUS shortage of American tank steamer tonnage is forecasted by Robert W. Morrell, superintendent of hull construction of the Standard Oil Company of New Jersey, in a paper presented before the recent meeting of the Society of Naval Architects and Marine Engineers. Up to the present time, the United States Shipping Board has made no provision in its shipbuilding programme for the construction of tank steamers, nor will it permit anyone else to place orders for building tank ships, in spite of the fact that the transportation of oil to Europe during the war will be one of the most vital necessities, not only for our nation, but for our allies. All of the tank steamers now under construction in the United States totaling about 64 vessels of 575,750 tons deadweight, are for 1917 or 1918 delivery. When these vessels are completed, the building of tank ships will, according to present indications, be at a standstill in this country.

The total number of American tankers now in service is about 170, having a total gross tonnage of 823,200 and a total deadweight cargo capacity of 1,180,000 tons. This represents about 20 percent of the total steel American tonnage exclusive of that on the Lakes, but by the time the government shipbuilding programme is completed it will represent a very much smaller proportion of our merchant tonnage.

As the requirements for oil in the navy and by our forces abroad will rapidly increase during the war, it is a serious mistake on the part of the Shipping Board to exclude tank ship construction in its shipbuilding programme. Without seriously interfering with the present programme, provision could be made for the construction of at least a limited number of tank vessels of standard type to be taken in hand as soon as the vessels now under construction leave the ways.

LETTERS TO THE EDITOR

"The Return to the Reciprocating Engine"

The undersigned has read with interest the article, "The Return to the Reciprocating Engine," as published in the November issue. This would seem to be the viewpoint of the situation as it might appear to one interested in turbine equipment, and would it not, therefore, be in order to offer the following criticism, or, if preferable, remarks from another standpoint somewhat, it is hoped, more impartial? In this connection it is felt advisable to preface what follows by the statement that the principals of the undersigned manufacture *both* reciprocating and turbine engines; also that the views now put forward are purely personal.

Exception is taken to the statement that "the turbine is obviously better adapted for this duty (continuous running, marine service) than the reciprocating engine," and it is open to question whether foreign navies "have appreciated this fact and have switched over from reciprocating engines to turbines wherever possible for this one reason." It is quite agreed that reliability is of paramount importance in all marine work, but to couple this remark with the above statement is a very broad and positive asssrtion which, in the opinion of the undersigned, lacks foundation. In foreign navies, as in the American navy, the turbine, as a prime mover, is, generally speaking, in favor, although not altogether on the ground of reliability; but it is felt, with all due consideration given as well to many other important factors, such as the saving in space and weight which results by its adoption for large units, economy in operation, etc. Also, and apart from the strictly engineering requirements, there are advantages resulting from the adoption which interest the naval architect in the way of armor belting, etc. It is, therefore, felt that to state that reliability alone is the reason for the adoption of the turbine is incorrect, as this question of turbine reliability is a very much discussed subject in marine circles where the majority of parties to such arguments appear willing to agree that the reciprocating engine does possess this feature. It is, rather, the reliability of the turbine which is so much discussed.

As for auxiliaries being driven, wherever possible, by turbines; this statement also is very much open to question and, as yet, European marine practice continues to favor the reciprocating engine both in naval and merchant work.

In respect to the third paragraph of the article and the question, "But will the men that will necessarily be called upon to operate these be really experiencd with any types of engines?" Surely the writer of the article does not hold the opinion that the authorities at Washington are planning to spend vast sums in the construction of a merchant fleet and then calmly turn same over to be operated by men without experience! The efforts which are being made to undertake the training of junior engineers and the co-operation of the navy in arranging for the supply of skilled engineers furnishes an answer to this statement which, it is hoped, should be conclusive as to the intentions of the Washington administration. It is to be regretted that the training periods must necessarily be all too short; but this fact would apply in any event, whether the men were instructed in reciprocating engine practice or in turbine operation.

But why call the reciprocating engine "obsolete"? This is entirely wrong and unjust, and, should you publish this letter, it is felt that the majority of your readers will agree that it is so. The merchant service, at least, will hold to the reciprocating engine for many years to come, and to state that the reciprocating engine only holds its own in this country because the "gear-cutting capacity of the country is taxed to the limit" cannot be accepted as conclusive.

To revert to the auxiliaries again. Why, in an open article, does the author continually refer to the forced draft gear? In respect to the remarks which are made in connection with same, presumably whether turbine or reciprocating sets were made use of, they would operate under the same steam conditions, and therefore no matter where the exhausts were led to, the results would be the same. Further, in the matter of economy, it is felt that there would be little to choose, in sets of the size under discussion, between the modern totally enclosed forced lubrication engine and the turbine. Undoubtedly, the turbine draft gear would not require as much space and would be somewhat lighter, but does its present design meet with the requirements of steady and continuous running and does the usual type of fan supplied at these high speeds actually meet forced draft requirements?

The writer is inclined to hold the opinion that turbine-driven draft gear for marine purposes is not yet fully developed or accepted and would draw attention to the fact that his principals, Messrs. James Howden & Co., Ltd., of Glasgow, originators of the heated air system and probably the best known forced draft specialists in the world, have not yet put on the market a turbine-driven fan set. Is there not something significant in this? The writer thinks so, for surely Messrs. Howden, through this world-wide connection, would be in a position to judge very accurately and impartially, since they are builders both of reciprocating and turbine engines.

New York. F. S. B. HEWARD.

More Vessels Needed for Coastwise Shipping in the Philippines

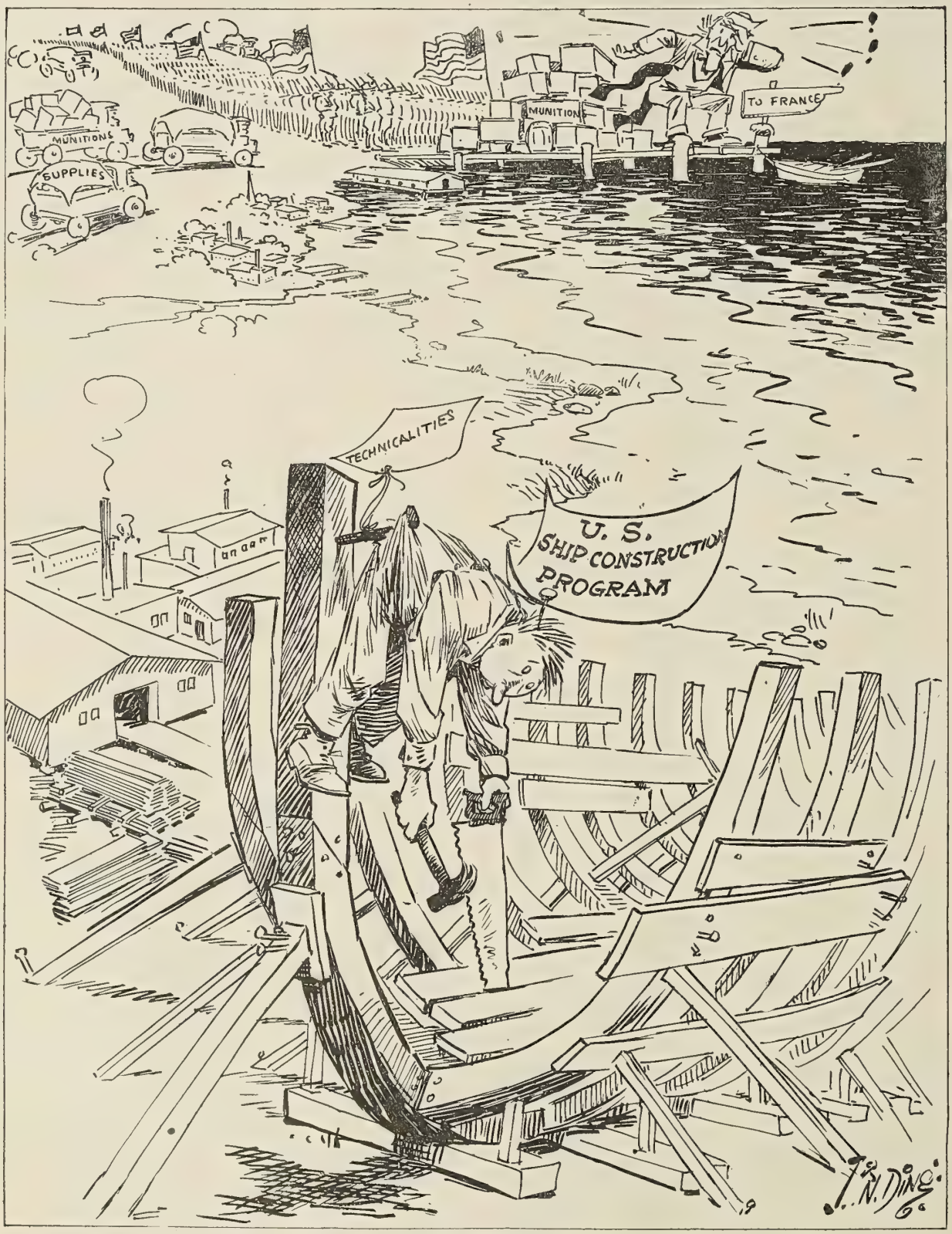
The coastwise trade of the Philippines is carried on by some 326 vessels of all descriptions. These vary in size from vessels of 1,845 gross tonnage down to 3- or 4-ton launches. Twelve of these vessels are over 1,000 tons, 12 are between 500 and 1,000 tons, 47 are between 100 and 500 tons, and 255 are below 100 tons. Of the whole number, 138 ply from Manila as their home port, 42 operate from Cebu, 31 from Iloilo, 13 from Zamboanga, and 2 from Jolo. Many of the smaller vessels are wind driven.

The coastwise trade of the Philippines is of growing importance, owing to the fact that the archipelago is made up of so many islands. Manila, while not the only port of entry, is practically so, especially for imports. Staple cargo is shipped from Iloilo, Cebu and Zamboanga occasionally, and cargoes are sometimes received at these ports. But the rule is that the foreign commerce of the archipelago is conducted through Manila. Consequently, the coastwise vessels are kept busy collecting exports for Manila and distributing imports to the remoter islands. During 1916 several vessels heretofore engaged in the coastwise trade were withdrawn and sold for use in other parts of the world, this having been one of the effects of the great demand for tonnage created by the European war. At the present time more vessels are urgently needed.

Rates on coastwise vessels are controlled by the Public Utility Commission. The rise in coal prices and the cost of repairs and operation caused a general rise in rates during 1916.

SHIPBUILDING PROGRAM DELAYED BY TECHNICALITIES

Cartoon Reproduced from the New York Tribune



Who's to Blame?

American Merchant Marine Must Be Unhampered by Restrictions from which Our Competitors Are Free*

BY EUGENE P. THOMAS †

OUR country has had to pay dearly for our abject submission to the decay of our merchant shipping in foreign trade. But the lesson has been learned, and with it has come a recognition of these fundamental principles; we must be enabled to freight our products to foreign markets at a cost not exceeding that which will be available to our competitors, and this will be possible only if we have an American merchant marine unhampered by restrictions from which our chief competitors are free. The British Shipping Industry which for generations has been, and is still, by far the greatest in the world, was built up by the exertions of the men engaged in it. It prospered because it was free from restrictions to which its competitors were subject. Theories to the contrary notwithstanding, we cannot have, in time of peace, an American merchant marine worthy of the name unless it be profitable to operate it without subsidy or subvention. This is manifestly not possible upon any practical or permanent basis so long as it costs more to operate an American steamer in ocean-going commerce than a foreign steamer in the same trade. Unsubsidized steamers have always been able to make a better showing for their owners than the subsidized ones, and it is certain that while a large majority of the British lines have received no subsidies from their Government, they have nevertheless grown and prospered, and have found no difficulty in competing with the subsidized lines. I repeat that what is necessary for the future growth and success of the American merchant marine is that it be placed upon a footing of equality with its chief competitors; with a fair field and no favor, repealing all laws which experience has shown to be detrimental to its growth, thereby leaving American enterprise free to achieve a success equal to that which the British Shipping Industry, unhampered by restrictive laws, has been able to accomplish.

The present plans of the United States Shipping Board, involving the building of millions of tons of ocean-going steamers, are not of greater consequence to the future of the export and import trade of the United States than they are to the maintenance of the steel industry on that high plane of efficiency and maximum output which it has reached during the past year. There has been afforded through the unexpected exigencies of this war a hitherto undreamed-of opportunity for governmental assistance in the upbuilding of a great merchant marine, as well as a striking illustration of the means by which American manufacturers can co-operate under government sanction and supervision for the supply of materials in enormous quantities. Idealized by the patriotism and loyalty which it has exemplified, we have had a close affiliation between the Government and the great industrial activities of the country, the value of which in solving the special problems of the present is of good augury for the service it may render in meeting the demands of the future.

* From a paper on "The Export Trade as Affected by the War," read before the American Iron and Steel Institute.

† President, United States Steel Products Company, New York.

National Chamber of Commerce Stimulating Recruiting of Shipyard Labor

Country-Wide System to Arouse United States to Importance of Shipbuilding and Immediate Necessity for More Men

IN its determination to turn out approximately 1,000,000 tons of ships between now and March 1, the Shipping Board and the Emergency Fleet Corporation will have the backing of the commercial leaders and business men in an elaborate plan of co-operation which will reach to every part of the country. Already, as a result of this effort, 35,000 shipworkers are wearing badges bearing the inscription, "War Service Ship Building, U. S. A." Also by means of patriotic posters and other methods of direct appeal enthusiasm for building ships to win the war has been stimulated.

In fact, through the National War Shipping Committee of the Chamber of Commerce of the United States every phase of the big problem now confronting the nation has been gone into, with the result that a great plea to shipworkers is now going forth through local chambers of commerce, trade bodies and organized meetings of citizens.

Quick Response from Commercial Organizations

No time has been lost by representative organizations joining the movement. Through the National Chamber War Shipping Committee, of which Edward A. Filene, of Boston, is chairman and N. Sumner Myrick, a well-known marine expert, vice-chairman, local committees have been formed by the following: Wilmington, Del., Chamber of Commerce, Newport News Chamber of Commerce, Chicago Association of Commerce, Tampa Board of Trade, Houston Chamber of Commerce, New Orleans Association of Commerce, New Orleans Board of Trade, Baltimore Merchants' and Manufacturers' Association, New York Merchants' Association, Newark Board of Trade, Seattle Chamber of Commerce and Commercial Club, Boston Chamber of Commerce, Philadelphia Chamber of Commerce, Charleston Chamber of Commerce,

New Poster for Recruiting Shipyard Labor

Savannah Chamber of Commerce, and the Augusta Builders' Exchange.

These local committees are planning to hold meetings with the shipbuilders and have some member of the Shipping Board or other marine authority address the gathering and thus bring the builders into closer relation. Many of these committees have formed subcommittees on labor, housing and transportation, these measures being one of the most important phases of the general problem.

Calling Former Shipbuilders into Service

The national committee, through its local committees, by way of co-operating with the Federal authorities, is making a survey of the labor resources in each district in an effort to secure the consent of employers to release, when needed, men formerly engaged in shipbuilding work.

There is no intention on the part of the committee to get labor away from one section to another. The object is to organize the resources in interior cities and towns so these places can be called upon to furnish men for shipyards when the need arises. In many interior centers there are those who have previously worked on ships. The committee through local organizations reaches such men. Volunteers who fill out a blank expressing their willingness to go to the coast and work in shipyards are given a shipworker's reserve button.

Badge Presentation to Reward Faithful Workers

The badges are worn by workers in shipyards as an emblem of the patriotic service they are rendering the country in time of war. They can be worn only by those actually working on ships. As a reward for faithful service every worker who has fulfilled his obligations at the termination of the war will be given his badge outright in the expectation that he will preserve it as a souvenir of his contribution to victory.

Some 50,000 black and white labels have been distributed which bear the slogan: "Win the War. RUSH Material for Ships." They are used on the outside of railroad cars, pasted on packages, wagons and automobiles—in fact, everything used in the transportation of supplies.

Many hundred recruiting posters have been distributed throughout the country. They are used by the local committees and in campaigns for interesting workers in shipbuilding. At the suggestion of shipbuilders who felt they ought to have something in the yards to urge the men to do their utmost in the work, a new poster has just been issued and is now being posted in the various shipping centers. It is shown on this page.

Representative Men on Committee

Besides Messrs. Filene and Myrick, above mentioned, the following are the members of the National Chamber War Shipping Committee co-operating with the Shipping Board: B. F. McLeod, of Charleston, S. C., president, Drake-Inness-Green Shoe Company; James W. Lee, of Newport News, American Bureau of Shipping; Charles Nagel, of St. Louis, formerly Secretary of Commerce and Labor; C. J. P. Mooney, director, Memphis *Commercial Appeal;* Crawford H. Ellis, of New Orleans, vice-president United Fruit Company; Harry L. Grant, of Chicago, Western Electric Company; J. C. Rohlfs, San Francisco, manager, Marine Department, Standard Oil Company; B. D. Caldwell, of New York City, president, Wells Fargo Company; Howard B. French, of Philadelphia, Samuel H. French & Co.; Charles E. Falconer, of Baltimore, president, the Falconer Company, and Judge Thomas Burke, of Seattle, Wash.

War Badges for Shipyard Workers

Shipbuilders' Training Center Established

Intensive Training of Shipyard Instructors Begun at Newport News on November 15 by Emergency Fleet Corporation

IT is fully recognized that further increases of working forces in the shipyards must be met through the training of men. Workers from a wide range of occupations must be secured and given short, intensive training courses to fit them for the special lines of shipbuilding work in which men are needed.

Instruction and training in shipbuilding, it is believed, can be given only by skilled workers in shipbuilding occupations. It is generally recognized that these skilled workers are not usually capable of imparting their trade knowledge to others, and in order that large numbers may be trained in a short time, the instruction given to workers must be as effective as it is possible to make it.

In order to secure competent directors and instructors in the individual shipyards, the Industrial Service Department of the Emergency Fleet Corporation opened on November 15 at the works of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., a school designated as the Instructor Training Center of the Emergency Fleet Corporation, where a series of short, intensive courses will be given in the method of giving instruction to groups of skilled shipyard workers, who will be selected by the shipyards themselves. This training center is in charge of a staff of industrial training specialists.

The first course at the new training center is being given to a group of about 200 men especially selected from the individual shipyards as the best qualified skilled workers to teach the beginners in the yard in which they are employed. Each shipyard has sent to the training center one or two prospective directors and a delegation of skilled workers, representing the trades in which trained men are most needed. Each prospective instructor is to be trained to teach only the trade in which he is thoroughly experienced. According to an agreement with the Emergency Fleet Corporation, the men detailed to receive instruction at the training center receive their regular wages from the yards which sent them, as well as the necessary expenses while they are taking the instructor training.

The staff of industrial training specialists in the service of the Emergency Fleet Corporation are putting these skilled workers in possession of effective methods of giving trained instruction to others. The instructor training experience is given to each group daily for a period of about six weeks. For one-half of each day the men receive instruction in how to teach others successfully. During the other half of the day the men are employed in actually instructing groups of workers in the Newport News shipyard under the supervision of the training staff.

When these men have completed their preparation as instructors they will return to their respective yards and set up training for the breaking in of new workers and for the advancing of employees from their present jobs to those requiring greater skill. Their places in the training center will immediately be taken by another group of men selected in the same manner to receive the same kind of training. These six-week periods of intensive training will be continued until a sufficient number of instructors are available in each yard to carry on effectively the instruction work required.

Recruiting Poster for Shipyard Workers

It is expected that as a result of this training one at least of the men sent from each shipyard will have shown himself to possess some qualifications of a fairly efficient director and that the other men will have had training to enable them successfully to serve as instructors and assist in the development of training schemes in their own yards. Each yard will then have a nucleus for a training department to which instructors may be added until the capacity is reached for giving emergency training to the number of workers required in the shipbuilding programme. The industrial training staff of the Emergency Fleet Corporation will assist the training department yards in the organization of their local training schemes.

Men selected as prospective directors of industrial training in shipyards must be natural leaders, have had experience in charge of men and show ability in directing groups. Preference will be given to men between the ages of twenty-five and forty having not less than five years' experience in shipyard work, and also who have had some technical education. The qualifications for prospective instructors are only slightly less stringent. The candidates must show evidence of possessing at least patience, dependability, regularity and clearness of expression.

The Men Who Will Build the Ships: How the Department of Labor Will Get Them

Methods the Government Will Use to Secure 125,000 Shipyard Workers—Prompt Action and Loyalty Vital to Success

BY C. T. CLAYTON*

INCREASINGLY is it becoming evident that the result of the war in Europe may turn entirely upon the speed with which America's contribution in men, military supplies and food can be delivered on the other side. It is essential that the programme of the Shipping Board should be carried out, not only on schedule, but if possible earlier than schedule.

That programme now contemplates construction within the next sixteen months of more than seven hundred ships; some under construction for private account, commandeered by the Shipping Board, to be finished for the account of the Government. These commandeered vessels will be about one-half of the projected tonnage, which amounts to more than six million tons. The remainder of this tonnage has been contracted for, to be built by perhaps a hundred shipyards scattered along the Atlantic, Gulf and Pacific Coasts, with a few yards on the Great Lakes.

How Many Workers Are Needed?

How many workers are necessary to fully man these yards and carry out the construction programme according to schedule? How many would be necessary to hasten that schedule and if possible to secure earlier delivery of these contracted vessels? There are several estimates. Considering the contracts alone, without regard to the vessels commandeered and already under construction, the total amount to be expended is some $450,000,000 (£92,400,000). Labor costs in shipyard construction run roughly, about 70 percent of the contract price. Therefore, about $315,000,000 (£64,700,000) probably will be expended in the wages of labor.

Wages are higher to-day than at any time in the history of the United States; many men are being paid well in excess of $5 (1/0/10) a day. The average wage of common laborers in the shipyards is about 32 cents (1/4) an hour. But considering that the steadiest employed workers rarely make over 250 days in a year, with an average usually 30 days less than that, it is probable that the average shipyard wage does not exceed $1,000 (£205) annually even to-day. But at $1,000 (£205) per year per man employed in the shipyards a total labor wage bill of $315,000,000 (£64,700,000) indicates 315,000 men required to conduct the labor from raw material to the finished ship. As raw material represents about 20 percent of the cost of a vessel, some 252,000 men will be required to man the shipyards employed in building these contracted vessels, the remainder being engaged in the mines, forests and mills behind the shipyards. There are now about 130,000 men working in these yards upon these vessels, therefore the problem of manning the yards for a one-shift day means the obtaining of about 125,000 workers. These workers are not all skilled men, but approximately are 40 per cent skilled, 40 percent semi-skilled and the remainder unskilled; or 50,000 skilled, such as machinists, shipfitters, anglesmiths, etc.; 50,000 semi-skilled, such as riveters, bolters-up, reamers, etc., and 25,000 unskilled laborers and helpers.

For ten years the Department of Labor had been conducting and gradually developing the national labor employment service known as the United States Employment Service. It commenced as a humanitarian service for immigrants, called the Division of Information in the Bureau of Immigration. But it seemed just a little unfair that such a service should be conducted and financed by the Federal Government solely in the interest of foreign-born immigrants to lead them from the slums of the cities into profitable employment when native Americans, taxed to support the service, themselves received no benefit from it. Therefore, the United States Employment Service almost immediately was undertaken, building upon two words in the statute phraseology, "to furnish information to immigrants *and others.*"

In the ten years since its institution in 1907, the United States Employment Service had expanded from a single office on Ellis Island to 94 offices scattered widely over 33 States of the Union and doing a business in finding jobs for workmen running up to 45,000 for the month of October, 1917. The service has a vast body of experience, the greatest possessed by any labor-finding machine in the United States, as it is indeed the only service crossing State lines. It has cared for the harvest needs of the country for the past four years, growing stronger and more efficient each season. It is the most economical organization for labor placement. Last year its cost of operation per person found employment was 65 cents (2/8½), compared with private employment agency charges, never less than $2 (8/4) for each job found, and often ten times that amount. This public agency, modest though it is, deserves a place in public affection beside our wonderful American Post Office Department.

The First Steps

At the beginning of hostilities the Shipping Board, a new organization of which the country then had hardly heard, announced its intention of constructing 1,000 vessels in aid of the Government's war programme. The plan was bold and well projected. The Department of Labor immediately offered the United States Employment Service to get the labor for the shipbuilding programme. Shortly thereafter, however, the Shipping Board became entangled in the unfortunate disputes which for several months very greatly delayed the shipbuilding programme.

Just before adjournment Congress gave the Department of Labor an appropriation of $250,000 (£51,250) for war emergency employment work. This sum is too small to take care of the tremendously varied war emergency labor needs of manufacturers doing construction work for the Government. The Department determined provisionally to expend the money to find the labor needed for shipbuilding. Its plan is very simple. In addition to the 94 offices it already conducts, and which will for the purpose of ship supply be managed as though part of the war emergency

* Special representative, United States Department of Labor, Washington, D. C.

service—the Department has invited the 108 State and municipal public employment bureaus throughout the country to join in one national ship supply service. Telegrams are now pouring into the Department of Labor from these States agreeing to join in this service; most of them already have registered hearty acquiescence.

Labor Supply Offices

At ports nearest each shipyard the Department will establish terminal labor supply offices. Such offices are now in existence at several ports; at two other ports office space is ready and the men are being selected to man them; at the other points offices will shortly be established. Radiating from these offices as centers, calls will be sent out through the unified public employment system for the men needed as fast as the yards are ready to receive them. In many cases housing questions, conditions in the plants and other matters must be met before any concentrated campaign for ship labor can be undertaken.

The Department does not desire at this time to conduct a nation-wide advertising campaign for labor. One reason is that the Department has so far been able to find practically all the labor desired without great difficulty, and there is no use in conducting a drag-net campaign until the supply of labor is less available. Those familiar with manufacturers' problems realize that to increase the permanent force of the shipyards by 125,000 men within the space of some six or seven months means recruiting a vastly larger force than that. The "turn-over" in shipyards is to-day in excess of 300 percent; it may reach 400 percent; that would mean the entire replacement of a shipyard's force every three months.

Reducing the "Turn-Over"

It is hoped that means to reduce this "turn-over" may be found and applied by the shipyards through improving conditions in the yards and obtaining habitable conditions in the nearby towns and villages. But under the best circumstances this "turn-over" will be likely to remain not lower than 150 percent; 150 percent "turn-over," complicating the general increase of 125,000 men, means about 382,000 men who must be found within the next six or seven months. Everything possibly adapted to cut down this drift in and out of the shipyards must be applied, and the United States Employment Service will do its share to reduce it.

Examination of Qualifications

Careful examination into the qualifications, experience and capability of the men before being sent to the yards is an element in employment service which seems never to have been fully recognized. In his very excellent study of the subject, Beveridge, the English scientist who established the great British labor exchange system, failed entirely to give this element any attention. Yet, obviously, it is no kindness to a man seeking employment to send him to a job he cannot hold, and the employment service which does not recognize this will itself lose the confidence of the employer and be of no value to the worker. Recognizing this, the United States Employment Service has been turning its attention to careful analysis of the men applying for work, with a view to placing them more accurately upon jobs which they can fill and hold and be satisfied in filling.

The Department of Labor is now completing the preparation of two books, one of which will carry definitions of every kind of occupation in shipyards—some 85 or 90 in all; the other, a little quiz book, which will enable the employment officers, as far as possible, to ascertain whether the applicants really understand the occupations for which they may apply. Accompanying these two books are the necessary report blanks to establish a genuine clearing-house service.

A second phase of employment service looks a little further ahead. It may become necessary as the supply of available and competent workers is reduced, to call upon men already employed in occupations adaptable for shipyard service, but upon production of less value to the safety of the country. This is what has been carelessly called "non-essential" industry. There are no non-essential industries, but there are grades of public value in industries. For the purpose of getting ready, in case such needs arise during the progress of the war, the Department of Labor has organized the United States Public Service Reserve, a separate bureau conducted under the Department.

Public Service Reserve

This Reserve conducts a most analytic classification of workers and professional men. Men now engaged in productive employment, but who are willing to consider changing their place of occupation to serve the nation better, are invited to join this organization. They fill out a blank, very carefully analyzing their capabilities, experience and aptitudes for service, and giving references to persons who know them. The facts stated in this application are registered in the files of the service. The kind of employment they are engaged in is carefully noted. When the time comes that labor cannot be found except by calling upon men in less essential occupations, the files of the United States Public Service Reserve will be available for the employment service to draw upon as the second line of defense.

The more general these files are of such workers the better for the general interests of business men and manufacturers; because if most, or all, men in mechanical occupations at least, are represented in these files it will be entirely practicable to so allocate the calls in percentages to be asked to go from any particular industry that that industry shall not be hurt or greatly hindered. If some process such as this were not thoroughly worked out and scientifically applied, and if instead of such a process the voluntary system were indiscriminately brought to bear upon any locality in which men could be obtained, we should find one industry untouched and flourishing while another industry would be entirely crippled or destroyed by the taking of men from it to the shipyards or to some other industry needing workers.

It is with a view to protecting the interests of all concerned, so far as possible, that the Department of Labor has projected and is rapidly establishing the United States Public Service Reserve and expanding the United States Employment Service as a most essential war service to the nation's workers and to the nation's business.

Agencies Enlisted

In projecting these plans, the Department of Labor is enlisting every agency. It is in close touch with the great Chamber of Commerce of the United States and with its special shipbuilding supply committee. The officers of this committee have given much patriotic service and counsel to the Department. They have come at its call on numerous occasions and have pledged their services, which will be of the most extreme value in setting up additional employment offices in many cities in the United States not now having any public employment office.

(*Concluded on page* 550.)

Men Who Are Recruiting 10,000 Officers for the New Merchant Marine

Front Row (left to right)—Prof. Carl C. Thomas, Johns-Hopkins University, Baltimore; Eugene E. O'Donnell, supervising inspector, 5th district, Steamboat-Inspection Service; Henry Howard, director of recruiting, U. S. Shipping Board; Capt. Irving L. Evans, Cleveland; William J. Grambs, Seattle; Farnham P. Griffiths, San Francisco.

Second Row—Dean Alfred E. Burton, Massachusetts Institute of Technology; W. Marriott Welch, assistant to director of recruiting; Henry G. Vaughan, Sea Service Bureau; Edward C. Hovey, chief, Sea Service Bureau; Edward F. Flynn, assistant to director of recruiting; G. Maurice Congdon, Providence.

Back Row—Winfield M. Thompson, field agent, Recruiting Service; Prof. Edward F. Miller, marine engineering department, Massachusetts Institute of Technology; James J. Raferty, president, and George H. Willey, business manager, Marine Engineers' Beneficial Association.

Training Officers for the Merchant Marine

Conference of Shipping Board Recruiting Service Officials Shows Genuine Revival of Interest in the Merchant Marine

ON October 26 and 27 a conference of officials of the United States Shipping Board Recruiting Service was held at the Chamber of Commerce, Boston, for the purpose of perfecting details connected with the work of training officers for the new ships of the merchant marine.

The Recruiting Service, which began its work in a small way in May last, has grown to be an important arm of the Shipping Board's varied activities. At present it is engaged in training deck officers and marine engineers at twenty-seven free navigation schools and eight free engineering schools. Not less than 12,800 deck and engineer officers will be needed for the 1,600 ships called for under the Shipping Board's present construction plans. A majority of these ships will take the water in 1918.

It is expected that the experienced, seasoned men now in the merchant service will be sufficient to take the senior posts on the new ships. The Shipping Board's schools are therefore devoted to training a sufficient number to fill out the complements thus started. The service is prepared to train not less than 10,000 men for this purpose. Only men qualified to meet the requirements of the Steamboat Inspection Service as to experience are accepted for training, except in the case of specially qualified men who will take special sea service after graduating from a school and before coming up for their licenses to secure the amount of experience required by the inspectors. In no case are inexperienced men taken for training.

At present not less than 350 students are being trained in each six-week term of the navigation schools, and not less than 275 students in each term of one month in the engineering schools.

The Recruiting Service of the Shipping Board is conducted largely by volunteers, men of business training with an interest in seafaring matters, who are giving their time to the Government. Henry Howard, of Boston, who originated the training plan and was appointed Director of Recruiting for the Shipping Board on May 29, is the head of the Merrimac Chemical Company and a member of the Council of National Defense Acid Committee. To aid him, Mr. Howard has a staff of volunteer workers to look after recruiting and the schools in various sections of the country, as follows:

For New England, G. Maurice Congdon, a steel merchant of Providence; for Pennsylvania, New York, New Jersey, Delaware and Virginia, Prof. C. C. Thomas, of Johns Hopkins University, Baltimore; for North and South Carolina, Georgia and Florida, Hardy Croom, manager of a transportation company at Jacksonville; for the Gulf Coast, Ernest Lee Jahncke, of New Orleans, a contractor and shipbuilder; for California, Farnham P. Griffiths, of San Francisco, an admiralty lawyer; for Oregon and Washington, W. H. Grambs, manager of a power company at Seattle; and for the Great Lakes, Captain Irving L. Evans, an admiralty lawyer of Cleveland. Cap-

tain Evans holds a master's license, unlimited, ocean-going. Mr. Grambs is a graduate of the Naval Academy. Mr. Jahncke is commodore of the Southern Yacht Club.

Mr. Howard also has a volunteer executive assistant, W. Marriott Welch, a Boston lawyer.

While the Boston conference was devoted chiefly to the details of working plans for enrolling and training men and placing them in sea service afterward, consideration was given to several matters of general policy. The substance of the reports of the section chiefs was that there is a genuine revival of interest in the merchant marine all over the country—especially on the Pacific Coast.

Licensed Steamship Officers to Aid Shipping Board Recruiting Service

AN advisory committee of licensed officers in the Merchant Marine, to work in conjunction with the United States Shipping Board Recruiting Service in securing officers and crews for the new ships to be added to the country's cargo fleets, was formed November 6 at a conference between representatives of the various officers' associations and officials of the Shipping Board Recruiting Service at the Boston Chamber of Commerce.

The committee, of which Henry Howard, director of recruiting for the Shipping Board, will be chairman, will include a representative of each of the licensed officers' associations on the Atlantic and Pacific coasts and the Great Lakes. It will meet the Tuesday before the first Wednesday in each month, at Boston, to discuss problems having to do with the manning of Uncle Sam's new merchant fleet.

It is expected that the close co-operation thus secured between representatives of the officers' associations and the Government will have a beneficial effect in the securing of representative American complements for the new ships.

Discussions at the conference showed a concert of opinion on the problems to be handled, which include regulation of the supply of licensed officers to meet varying demands of the constantly growing service, exemption of trained men in the merchant marine from military duty, and the building up of an all-American merchant marine.

Delegates to the Conference on Officering Emergency Fleet Cargo Vessels Held at Boston, November 6, 1917

Front Row (left to right)—Prof. Carl C. Thomas, Johns-Capt. Robert M. Lavender, National Trustee, American Association of Masters, Mates and Pilots; Henry Howard, director of recruiting, United States Shipping Board; William S. Brown, National President, Marine Engineers' Beneficial Association; Capt. Arthur N. McGray, secretary-treasurer, Neptune Association, also representing the Masters, Mates and Pilots of the Pacific Coast.

Middle Row—Capt. Ulster Davis, National Trustee, American Association of Masters, Mates and Pilots; Capt. Luther B. Dow, business manager, American Steamship Licensed Officers' Association, Inc.; George W. Willey, business manager, Marine Engineers' Beneficial Association, No. 59, of Boston; James J. Raferty, Jr., president, Marine Engineers' Beneficial Association, No. 59, of Boston; Capt. Irving Sparks, Boston agent, Neptune Association.

Back Row—Winfield M. Thompson, field agent, U. S. Shipping Board Recruiting Service; Edward Clarence Hovey, Jr., chief, Sea Service Bureau; Bert L. Todd, secretary, Ocean Association of Marine Engineers; Thomas A. King, chairman Board of Directors, Ocean Association of Marine Engineers; Henry G. Vaughan, Sea Service Bureau; Edward F. Flynn, assistant to director of recruiting, U. S. Shipping Board.

The officers' associations were represented at the conference by Captain Arthur N. McGray, secretary of the Neptune Association of New York, who also represented, by request, the Masters', Mates' and Pilots' Association of the Pacific Coast; Captain Luther B. Dow, of New York, business manager of the American Steamship Licensed Officers' Association; William S. Brown, of Buffalo, national president of the Marine Engineers' Beneficial Association; James J. Raftery, of Boston, president, and George H. Willey, business manager, of the local branch of that association; Captain Irving Sparks, Boston agent of the Neptune Association; Captain Robert M. Lavender, of Boston, national trustee, American Association of Masters and Pilots; Captain Ulster Davis, of Albany, holding a similar position; Bert L. Todd, secretary, and Thomas A. King, of New York, chairman of the directors of the Ocean Association of Marine Engineers, N. Y.

The Shipping Board Recruiting Service was represented by Director Howard, Edward Clarence Hovey, Jr., and Henry G. Vaughan, of the Sea Service Bureau; Edward F. Flynn, assistant to director; Winfield M. Thompson, field agent, and Captain Eugene E. O'Donnell, supervising inspector, Fifth District, U. S. Steamboat-Inspection Service.

The War's Effect on Merchant Shipbuilding*

Enormous Tonnage Required by the Government—Increased Shipbuilding Facilities—Types of Ships—Standardization—Labor Problems

BY HOMER L. FERGUSON †

THERE have been two schools of thought regarding the proper method of meeting the German submarine campaign. One school has held that only by the production of the maximum number of ships in the shortest space of time until the production of new vessels should more than equal the destruction of vessels in being would the question be answered. The other school has held that there were vessels in plenty to feed England and to carry our troops to France and to feed them, and that the proper method to meet this menace was to build a large number of submarine chasers, destroyers and other vessels of war to go after the submarine itself.

The exponent in an official way of the theory of building the maximum number of ships is, of course, the United States Shipping Board, with the Emergency Fleet Corporation as the largest individual owner and builder of merchant ships anywhere, either at this time or at any other time, in the history of the world. All of the shipbuilders have had their new ships commandeered by the Shipping Board, and these ships are now being pushed to completion under the direction of the Shipping Board. In addition to the ships under construction at the time the Shipping Board took over all these vessels on August 3 last, the Shipping Board has placed contracts for 200 to 300 additional steel ships and for about 200 wooden and composite ships. The English have built ships at a very rapid rate during the past six months, but prior to that time their capacity had fallen off woefully. The figures of British shipbuilders are that in normal years their capacity in tons was about two million. In 1915 they built only 700,000 tons. In 1916 only 550,000 tons. In the first six months of 1917 they built 500,000, and by the end of 1917 they will have built during this year almost 2,000,000 tons, or practically their normal tonnage.

Capacity of American Shipyards

In comparison, it is interesting to look at our record, which is mostly in the future. The largest tonnage ever built by us in any year prior to the present year was in 1908, when we built 615,000 tons. In 1917, or at the end of the fiscal year of 1916-17, on July 1, the total tonnage turned out in merchant ships in this country was close to 800,000 tons. Of course we expect that that will be bettered very much, and the production, except for labor difficulties, would have been very much greater than that; but it is a far cry from 800,000 or 1,000,000 tons of ships a year to a prospective 2,500,000 to 5,000,000 tons of ships a year, and especially when we consider that the best the first shipbuilding country of the world ever did in any one year was only 3,000,000 tons.

Now as to the methods of turning out such an enormous tonnage in a short time. If the war does nothing else for shipbuilding, it will at least demonstrate that the individual tastes of individual owners need not be met in every instance. Hitherto ships have not been built alike for the reason that ships were built by units and tens instead of by thousands. But with a single ownership, like the Emergency Fleet Corporation, it becomes possible for the owner to specify that all ships shall be alike, and thus we have standard ships!

There is an idea extant that if a ship is called "fabricated" or "standardized" it becomes rather easy to build. It does become easier to build, but it is not any easier to drive a rivet in a fabricated ship than in a common ship, and the 7,500-ton fabricated ship will have about 650,000 rivets and some riveters must do a considerable amount of work to drive those rivets in that ship the same as in any other ship. The most onerous work in building a ship is in the driving of the rivets; and if any concern is going to build one ship a week, it must drive 650,000 rivets a week. When we consider that the best rivet drive is by the Union Iron Works, where they drive 250,000 rivets a week, and the next best by the three largest shipyards on this coast is about 200,000 rivets each per week, the problem of driving 650,000 rivets a week assumes a rather difficult aspect to the casual observer. Still, we all hope it will be done, but if it is done it means the importation of an enormous number of new workers into the industry.

The Fabricated Ship

The fabricated ship has the center of the stage at the

* Extracts from address delivered at a Joint Meeting of the Engineers' Club of Philadelphia and the Philadelphia Section American Society of Mechanical Engineers at Witherspoon Hall, Philadelphia, October 16, 1917. Reprinted from the *Journal* of the Engineers' Club of Philadelphia and Affiliated Societies.

† President of the Newport News Shipbuilding and Dry Dock Company.

present time. In England a standardized ship was adopted which is very much like a fabricated ship, and they are being turned out at a rapid rate. The fabricated ship, like the English standard ship, has the disadvantage of low speed, and at the same time it has the advantage of a large carrying capacity. The records of submarine sinkings, such as have been gathered, indicate that speed is probably the safest defense against the submarine. The number of very slow ships sunk is very great in proportion to the number attacked. Probably 90 percent of the slow ships are sunk when attacked by a submarine. As the speed becomes greater the immunity of the ship from torpedo attack becomes greater—not only because she presents a more difficult target, but also because the vessel may run away from the submarine in darkness or in daylight if she has a greater speed than the submarine has on the surface, and also because the vessel may be maneuvered much more quickly. One of the most gratifying things about submarine warfare is that the torpedoes are not making the speed as in the early days of the war. The speed of the torpedo has undoubtedly become much decreased. Just why we do not know, although it is probably due to the absence of tungsten and manganese and some other ingredients now so difficult to obtain in Germany. Vessels of 16 or 17 knots have actually dodged the torpedoes.

The vessel of 16 or 17 knots is also needed to carry soldiers. We are shipping all our soldiers to Europe in vessels of 14 knots or over because it is thought to be too hazardous to ship them in slower vessels. We have at the present time in this country enough vessels in commission to ship soldiers to Europe at the rate of not more than 1,000,000 a year. That includes all vessels of 14 knots or over. But, by building a large ship as well as a speedy ship an additional factor of safety is obtained, which may be illustrated by stating that a torpedo will blow just as big a hole in a little ship as in a big ship. When a small, short ship has a large hole in it a relatively larger proportion of its length is open to the sea. When a similar hole is blown into a long ship a very much smaller proportion of that vessel is open to the sea. So that it is perfectly possible to design, and practical, indeed, to design, a ship of 500 or 600 feet long, so subdivided that it will take two and probably three torpedoes of the German variety and still stay afloat. The design, however, must be of such character that when the compartments are flooded the ship will still remain upright. The ordinary passenger ship is modeled with a small metacentric height, and three-fourths of them, when bilged or torpedoed, will probably turn over before sinking.

A great deal of talk was heard years ago, when the *Titanic* went down, about making ships safe. The *Titanic* was probably the safest ship that ever crossed the ocean, with the exception of the *Olympic*. The *Empress of Ireland*, the *Lusitania* and the whole host of passenger ships of which we have any record, have turned over as they went down, and they probably righted after they went down. So that in designing a ship that will be safe against submarine attack not only must the question of subdivision be taken care of so as to limit the length of the vessel that may be damaged by a torpedo, but also that the vessel when torpedoed will remain upright and be able to get into port. A number of vessels have been torpedoed and have been towed into port and repaired on the other side, even after the crews had deserted them.

The larger type of ship which will probably be built before the war is over by a number of concerns in a position to undertake this work will be designed with a high speed for troop transport, with a close subdivision to make the ship safe, and with a large amount of stability so that the vessel will also be safe against turning over.

Types of Vessels Developed

The war so far has developed, or called attention to, three distinct types of vessels: The standardized or fabricated ship which both England and the United States have adopted, the large troop transport which has been described, and, in addition, a submarine chaser.

In addition to these three types of ships brought out by the war, there has been a very definite attempt to rejuvenate what some of us have considered a dead industry. We have a few of the older wooden shipbuilders left, but the building of a wooden vessel, to my mind, is so much more difficult than the building of a steel vessel and requires so much higher skill than does the building of a steel vessel, that I wonder how they can ever expect to build them.

Wooden Ships Ineffectual

I do not believe that a 288-foot wooden ship built in a lumber yard, either south, west or north, and necessarily by men who are not expert ship carpenters, will ever relieve any great distress on the other side of the water, caused by lack of fuel or food. On the other hand, these vessels may be used in our own trade at home. My chief regret is that they are not made shorter, because when such ships are over 200 feet long it is rather difficult to hold the ends up. If we get more vessels through building wooden ships, let us build them, but it is unfortunate that the type was settled before many professional wooden shipbuilders were on the job. The wooden shipbuilders, of course, have taken a good many men from the steel shipyards and have lessened production to just that extent; but, on the other hand, they will add a very considerable tonnage, now that practically all our large coastwise ships are either going abroad or are in way of being commandeered for foreign service, so that the wooden ship will serve a useful purpose.

Standardization

The standard ship probably offers the best opportunity for a large increase in our tonnage. The standard ship has been built on the Great Lakes for years. Shipbuilding there has become largely a manufacturing operation, for the reason that the ships themselves simply form a part of the manufacturer's business of carrying iron ore from Lake Superior down through the canal to the eastern points, where it is shipped to the steel furnaces. The loading and unloading of the ore permitted the standardization of docks, hatches and so on, and the method of construction became standardized because the work which the ship did was standardized. Many ask why we do not build ships just as they do on the Lakes, and the answer is that we do not do the same work that they do. On the coast, with the coal trade, there has been some effort toward standardization. With the standardized ship the main benefit is not in the hull of the vessel, or in the fabrication of the vessel in the steel mill. The main benefit is that the machinery and the outfit, the winches, the pumps, the steering gear, the engines and boilers and all the thousand and one things that go into the ship are standardized and may be produced in large quantities at some point other than the yard of the builder. The standardization of the fittings of a vessel are more important to my mind than the standardization of the hull. The amount of money saved in the latter will be the money to build the templets, patterns, etc., amounting to not more than 12½ to 15 percent of the

labor cost of the hull. We are told, too, that all the riveting will be done at the steel mills. It probably will not, and if 20 percent is done it will be more than I think will be done unless the railroads will carry pieces of steel as large as this auditorium.

Standardized Ship Fittings

Shipyards have naturally tried to standardize within their own practice the fittings that go on the various ships they build, and a great step is being made in that direction by one of the largest corporations in the country. The Bethlehem Company owns so many shipyards that they are in a position to standardize as between their various yards, with the result that there will be considerable saving in cost and in time in the production of all the things that go into a ship. But in building the standardized ship, or in building any other ship, the real problem is not the problem of equipment; it is not the problem of money even; it is not, except in part, the problem of location, but it is the problem of men. A very simple lesson in arithmetic will indicate that if 100,000 rivets are to be driven in one day and any one gang of riveters will drive 300, then it will take so many men and boys and helpers to get that drive.

Shipyard Labor the Real Problem

It is quite desirable to get back to our arithmetic again when we have built so many ambitious high hopes of what we expect to do. For instance, on the Delaware and on the Chesapeake, which we on the Chesapeake are pleased to consider the two largest shipbuilding communities in the United States, there are at present about 33,000 men employed in the shipyards. There could be employed to advantage in these same yards at this time a total of 48,000 men, and within the next six months, or the next nine months at the latest, these same yards, barring the fabricated shipyards, could employ to advantage a total of 60,000 men. So the problem becomes arithmetical again. You have 32,000 men working. To get the maximum production out of the shipyards already in existence you will need to use 60,000 men. Where are the 28,000 extra trained shipbuilders to come from? Add to that the fabricated shipyards, which, on the Delaware will probably require 20,000 men, and in the vicinity of New York an extra 10,000 and we have in this immediate district need for approximately 60,000 new mechanics in the shipbuilding business.

150,000 Shipyard Mechanics Needed

According to Admiral Capps, there will be needed in the whole United States in shipbuilding within the next six months an additional 150,000 men. Now, consider for a minute where these men must come from or how we are to get them. In the first place, most shipbuilding men or mechanics require both skill and experience. We can give them the experience fairly quickly, but we have not time to give them the skill. In other words, it is necessary that men be recruited from industries where they do work similar to the work of shipbuilding in order that they may become quickly adapted to the work of shipbuilding.

The problem of oversea transportation absolutely has to be met before we can get into the war effectively, and the problem of sea transportation is probably the most difficult of all problems we have to face. Therefore, the men should be furnished for the solution of this problem, no matter what industry they are taken out of. The problem of building these ships becomes the most important single problem that confronts us at the present time.

Control of Shipyard Labor

I do not say that I favor the conscription of laboring men, but I do say this—that sooner or later the United States will tell all men who are essential in any industry or any occupation in the prosecution of the war that *this* is their job and they are to stay by it until the war is over. It is perfectly ridiculous that our men who are already in Europe and those who are going there now should for a minute suffer on account of some difficulties that arise between employers and employees in the great shipyards of this country. Not only should the man who pounds iron and drives rivets be told that he shall be kept on his job, but also every employee in the company, from the president down to the office boy, is to do the same thing, and he is not to seek or obtain other employment, except for good reason given the Government authorities. If we are in the war to win, no one should be timid about telling the laboring man or the unions or anybody representing them just what part they have got to play along with the part that other people should also play.

It is held by the National Council of Defense, and by a number of exalted bodies that the *status quo* as between employer and employee should remain the same during this war. Of course, it should remain the same, and we all know that it is not remaining the same, and we all know that the labor leaders as a rule are unable to control the men. I do not see why of all the men who have been passed into the National Army we should not have in as essential an industry as shipbuilding those of them who are mechanics on conditions set by the Government and on pay to be approved by the Government, to work in these shipyards until the war is over, or until they should perchance prefer to go to the front instead of staying in the shipyards.

I understand that in Philadelphia it is very difficult to have any of the shipyard employees excused from military service. Of course they have their own rules to go by in Washington, and we must all abide by them, but it is rather unfortunate that they should be differently interpreted in different parts of the country and it seems to me most unfortunate that the shipbuilders have been allowed to go to the front. The experience of England was that they had to take out of the trenches not only the shipyard workers but the ammunition workers and send them back to the factories again. It is a pity that we could not profit by that. That would be a solution that would help very much with this laboring man difficulty.

Fixing Wages

The demand is largely in excess of the supply of men. The sympathy of the Government is with the men. At our Navy Yard under the law we pay the going rate in that vicinity and arbitrarily fix the rate at a larger rate than the going rate in the vicinity which we have to meet, and we are told in case of difficulty we must keep going, so it is only a question that can be worked out by the Government's representatives and the shipyard employers together.

I would be perfectly willing to see all the shipbuilders go down to the Navy Department and Shipping Board and say, "We will agree with you on these conditions and stand by them and will shut up our shop before we pay any more." Of course it can be said that a man who works is entitled to any wage he can get. Perhaps he is, but he is not entitled to stop working now, and he is not entitled to say that any other man shall not serve an apprenticeship now. He is not entitled to say that a helper shall not do a mechanic's work if he can do it. How perfectly ridiculous when a million and a half of

the best young men that we have in the whole United States are serving an apprenticeship in the war, leaving their homes and going out to learn the art of soldiering in a very short time, and quite as difficult work to learn as riveting. What a ridiculous thing to say at a time like this that a man cannot get a job unless he has served his time at the trade, and tie the hands of the United States in this great war, which it must win if you and I are going to keep on being proud of living in the United States.

I was shown to-day in the case of a number of workers that the money which they could earn in a day was limited by the organization to which they belonged, and that if they earned that much money at two or three o'clock in the afternoon they would work no more, notwithstanding the fact that the management wanted them to do it. When will people ever learn that production by the use of labor-saving machinery to get a large production per man is all that gives us more than we ever would have otherwise or than we ever would have had before the days of large production? And yet they have limited production with the idea of giving more jobs to more men in time of war when we have not got enough men and have about three jobs for one man!

Housing Shipyard Workmen

The condition of laboring men who are gradually coming in from the West to all the seaboard towns is a very difficult one, and a great deal of the basis of discontent is a lack of suitable housing conditions. That is ordinarily taken care of in the towns and cities by real estate people and those who build for investment, but at the present time that method is wholly inadequate, and this question will have to be considered along with the same programme as that for our army which is being installed in cantonments all over the United States. The Government is waking up to this in the case of some recent contracts let for destroyers. The Government itself will finance the building of barracks or temporary hotels for the men, so that several hundred can be housed at or near the shipyards where the work is to be done. One of the biggest problems England had was the formation of new communities and the building of whole towns. In some cases, they were almost ten miles square, and in them were provided not only ordinary houses and living accommodations, but public parks, playgrounds, theaters and everything needed in a modern town.

The shipbuilding problem comes back to the question of men and willing men—willing to do work under conditions which their own Government and our representatives say are fair and honorable both to the Government and to the men, and I say that if they will not work under conditions such as the Government specifies and at the rates of pay which the Government calls fair, then they should either be made to, or made to let alone the men who are willing to do so.

I cannot imagine the United States letting stand in its way any band of men whatever when the national honor and national life, in fact, depends on our winning this war, and when we are sending forth our young men and boys by the thousands to France.

Treat Everybody Alike

As a business man, I do not know of any man in the shipbuilding business who would care, and I, myself, do not care how much of my income the Government takes, as long as it treats everybody else the same, and as long as the business is left with enough money to carry on its operations and pay a most moderate return to the owner and be able to serve the Government in the best way. I do not care how much of the profit of the business they take, and I will go further than that. If it becomes necessary for the raising of money, a conscription of capital would not hurt my feelings at all. We are willing, if necessary, to have the plants commandeered by the Government, under the terms of the United States and under conditions which they see fit to impose but we do insist that managers, foremen, superintendents and men shall all be treated alike.

Those of us who are building ships or destroyers have a very difficult time in securing priority in getting material. We have received from the Navy Department and from the War Department and from the Shipping Board orders to proceed with the utmost vigor and despatch to do their work, each in the same tone of voice, each with equal authority, all vested in these various departments by Acts of Congress, so that actually what has happened is that the president of our Company has had to settle the question of priority himself—an entirely improper function for him. The question of priority and preference is now the biggest industrial question there is, for the very simple reason that the total production of the United States has been over-absorbed by these war activities.

Priority in Getting Material

With the prices settled, the only important thing is, who gets his first, who second and who third. We have in the War Department six bureaus buying frequently in competition with each other. We have in the Navy Department five or six bureaus buying, or recommending to buy, not in competition with each other very much, but somewhat. In the Shipping Board we have a tremendous amount of buying going along more or less in competition with the War Department and the Navy Department. The Government simply wants to get the material in such quantities as it can, but it is simply impossible to satisfy all these Bureaus and Departments. What is the answer?

Munitions Minister Needed

The answer that has been found in Great Britain in the very first months of the war was to divorce the question of business, buying and price fixing from the naval and military activities of the country. A munitions minister was appointed; just the kind that we need. The Chamber of Commerce of the United States recommended that a Board be appointed. I am a director in that Chamber, but I think a minister should be appointed, because you want a *man* who will coördinate the interests of the country. What have we in our country? We have great army cantonments. We have great army and navy orders from the Government and are competing day after day; we do not know who is first, second or third. I am sure that the Secretary of the Navy and the Secretary of War have both plenty to do to run the operations of their great departments without working a large part of the time with the question of buying, and whether they are going to get this first, second or third. We have a Priority Committee, but they cannot settle it, but only recommend it. Actually, the best buying is done by the official who is the most zealous, so that we run great risk, if that keeps on, of having our soldiers on the other side with plenty of guns and maybe gunpowder, but not enough baked beans or peas or something that they need. It must be done in some way so as to least upset the country.

Another reason that business should go on as well as possible because we have to earn some money somehow in order to meet the war taxes, and there is no need

of disrupting it unnecessarily in buying in various ways. That has had a bad effect on the shipbuilding business.

Forging Situation a Weak Point

The weakest point in the shipbuilding business is the forging situation, in my judgment. There are not enough forges in the United States to turn out all the forgings required for the shipbuilding. The great Bethlehem Company, Midvale, and the Allis-Chalmers are practically the only large ones we have, whereas Great Britain has twelve or fifteen very respectable forging concerns. It is absolutely necessary that someone determine whether this or that or the other kind of forgings shall be first; otherwise a lot of us are apt to end up with hulls but no machinery in them. But we would very much appreciate it if we could go to Washington and say to someone that this is the most important, and that is the next, and that is the next. Instead of that, we appeal from one department to another and frequently end up with nothing.

I am mentioning this to you because it is very much in my heart and mind; I see it in Washington every time I go there, and I hope very much that next winter when the question comes up in Congress they will see fit to centralize the buying of war materials instead of scattering the work among the Navy Department and the War Department and the Shipping Board.

Training Shipyard Workers

We all know that it is a joy to have a few good mechanics and give them a job and forget about it, but we have to get away from that and to teach new people, which may, fortunately, be done with ships of standard make and duplicate makes. The biggest problem that the employment managers have at the present time is to get hold of the best material possible, house it as decently as we can, and teach it shipbuilding as quickly as possible. The problem almost dazes one to contemplate. It can only be solved by bringing in enormous quantities of new men, and which must be done without any hindrance. The leaders of the unions have stated that they would allow this to be done. We have to do it, and no matter what else happens we must insist upon the right to break in any number of new men in the business. The Shipping Board will back it up, and I am sure that sooner or later the Administration itself will insist upon that being done on such a comprehensive scale as to make it possible for the United States to carry out its great shipbuilding programme, which *must* be carried out.

S. S. Sylvan Arrow.—The third ship of a contract for four that was placed with the New York Shipbuilding Corporation, Camden, N. J., two years ago by the Standard Transportation Company of New Jersey, was launched on October 16, ninety-two percent complete, her keel having been laid on March 22. If it were not for the fact that the ship has been commandeered by the Government, and extra work was required by the Shipping Board, the vessel would have been able to leave the yard within about three weeks after the launching. The vessel is a tanker of the shelter deck type, built on the Isherwood system of longitudinal framing, with the boilers and machinery aft, as is common for oil tank steamers, and the cargo pump room amidships. The hull is 485 feet overall, 468 feet 6 inches between perpendiculars, 62 feet 6 inches molded beam, and 39 feet 6 inches molded depth to shelter deck. The draft on a summer freeboard is 26 feet 6 inches. There are 20 main tanks with a combined capacity of 3,500,000 U. S. gallons and 10 summer tanks with a capacity of 450,000 U. S. gallons. The fuel bunkers hold 720 tons of oil. Propulsion is by a four-cylinder, quadruple expansion, surface-condensing engine with cylinders 24 inches, 35 inches, 51 inches and 75 inches diameter, with a stroke of 51 inches designed to develop 3,200 indicated horsepower at 82 revolutions per minute. Steam is supplied at a working pressure of 220 pounds per square inch by three single-ended Scotch boilers fitted for both coal and oil burning.

Reinforced Concrete Motorship Launched Bottom Upwards

THE series of photographs shown on the opposite page illustrates the launching of the 200-ton reinforced concrete motorship *Beton* 1 at the yards of the Porgrunds Cement Construction Company, Porgrunds, Norway, in August, 1917. As shown by the illustrations, the vessel was put into the water with the keel uppermost, and after a period of fifteen to twenty minutes slowly righted herself.

This novel method of launching was adopted, not by reason of any inherent advantage in the launching operation itself, but on account of the methods used in constructing the boat. In the first place, an inner hull of wood was constructed with the keel uppermost, which served as a mold around which the concrete was poured for forming the hull. After the mold was made, the reinforcement and the cement were formed around this, and, when the construction was complete, the entire structure, including the mold, was launched into the water in the position in which it was built.

The inner mold was divided into water compartments, a center compartment being open to the water. The air in this and in side compartments next to the bottom of the vessel was gradually exhausted through vent pipes after the vessel was in the water. Side compartments immediately under the deck of the vessel, however, remained filled with air, so that as the part of the mold open to the water was gradually filled with water the center of buoyancy was lowered below the center of gravity and a moment exerted righting the craft to her normal position in the water. The flooded compartments were then pumped out and the inner wooden hull removed to be used again as a mold for the construction of another vessel.

After launching, the vessel was equipped with a 70-horsepower Skandia motor.

New Navy Specification for Steel Castings

New specifications governing the manufacture of steel castings have recently been issued by the United States Navy Department. They are dated May 1, 1917, and are designated as 49 Std, superseding those issued June 1, 1916. The chemical and physical properties demanded by these specifications are as follows:

PHYSICAL REQUIREMENTS

Grade	Percentage Chemical Composition (not over) P.	S.	Minimum Tensile Strength, Lb. per Sq. In.	Minimum Yield Point Lb. per Sq. In.	Minimum Elongation Percent in 2 In.	Minimum Reduction of Area, Percent	Bending Test † (not less than)
F*.....	0.05	0.05	85,000	53,000	22	35	120 deg.
A.....	0.05	0.05	80,000	‡	17	20	90 deg.
D.....	0.05	0.05	70,000	‡	22	30	120 deg.
B.....	0.06	0.05	60,000	‡	22	30	120 deg.
C.....	0.06	0.07	.....	.....	..	..	.....

* Grade F castings may contain nickel or other alloying metals.
† Cold bend about an inner diameter of 1 inch.
‡ Forty-five percent of tensile strength obtained.

NOVEL LAUNCHING OF REINFORCED CONCRETE SHIP

By Porgrunds Cement Construction Company, Porgrunds, Norway

Fig. 1.—Concrete Ship—Bottom Up—Just After Launching

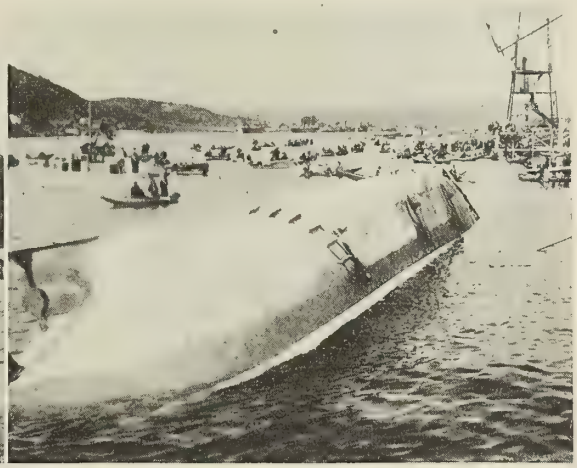


Fig. 2.—Concrete Ship Beginning to Heel Over

Fig. 3.—Heeling Over

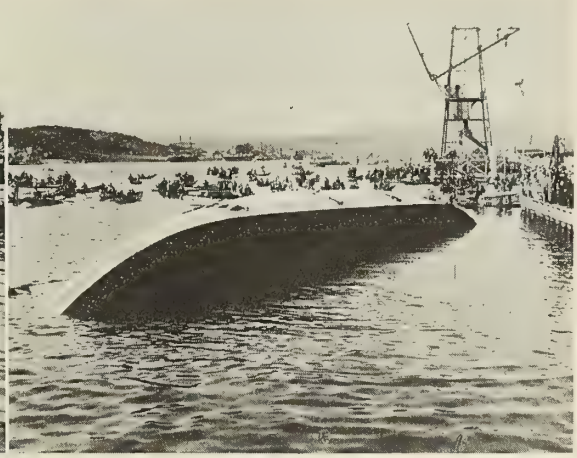


Fig. 4.—About to Right Itself

Fig. 5.—On an Even Keel

Fig. 6.—Ready for Pumping Out

Fig. 1.—S. S. *El Capitan*

New Southern Pacific Freighters

Single-Screw Vessels Built at Newport News for Southern Pacific Company Atlantic Steamship Lines

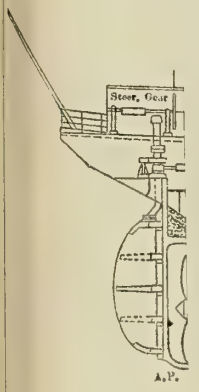
TWO sister ships, the *El Almirante* and *El Capitan*, of the ocean-going hurricane deck type, each with a deadweight carrying capacity of 8,500 net tons on a mean draft of 25 feet 6 inches, have recently been built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Southern Pacific Company, New York. The vessels were designed and built under the supervision of Mr. A. S. Hebble, superintending engineer of the Southern Pacific Company Atlantic Steamship Lines, to whom we are indebted for the following particulars:

The principal dimensions of the vessel are:

Length overall	380 feet 3¼ inches
Length between perpendiculars	364 feet
Beam, molded	51 feet
Depth, molded to hurricane deck	33 feet 6 inches
Depth, molded to main deck	25 feet 4 inches
Mean draft, loaded, in salt water, not to exceed	23 feet
Total deadweight capacity (at 2,240 pounds per ton)	6,200 tons
Designed speed	11 knots

As shown by the general plans, the design calls for a single-screw steamship with straight stem and elliptical stern rigged with two pole masts. Three complete steel decks are fitted fore and aft with an oriop deck in addition in the forward hold extending from the collision bulkhead to the after No. 1 hold bulkhead. The hull is constructed on the transverse system of framing with a single bottom throughout except in way of the engine room and twelve frames abaft of the engine room, where a double bottom is worked in. The compartment under the engine room are used for reserve feed water, and the compartments aft of the engine room for oil fuel. The forward and after compartments of the vessel are fitted with trimming tanks and a deep ballast tank is fitted aft of the engine room. The after peak tank is arranged for carrying fresh water for boiler feed and domestic purposes. Two fresh water tanks, with a capacity of about 4,500 gallons each, are located in the engine room and arranged for both boiler feed and domestic purposes. A cross bunker and side bunkers are fitted below the lower deck to carry oil fuel.

Cargo is handled through five centerline cargo hatches and in addition there are six side cargo ports on each side. The cargo hatches are served by cargo booms of wood fitted to the two steel pole masts and two steel derrick posts, each capable of handling 7½ tons and operated by



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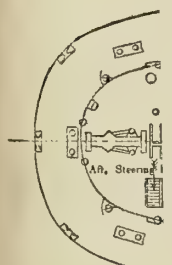


NEW SOUTHERN PACIFIC FREIGHTERS

Built by Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

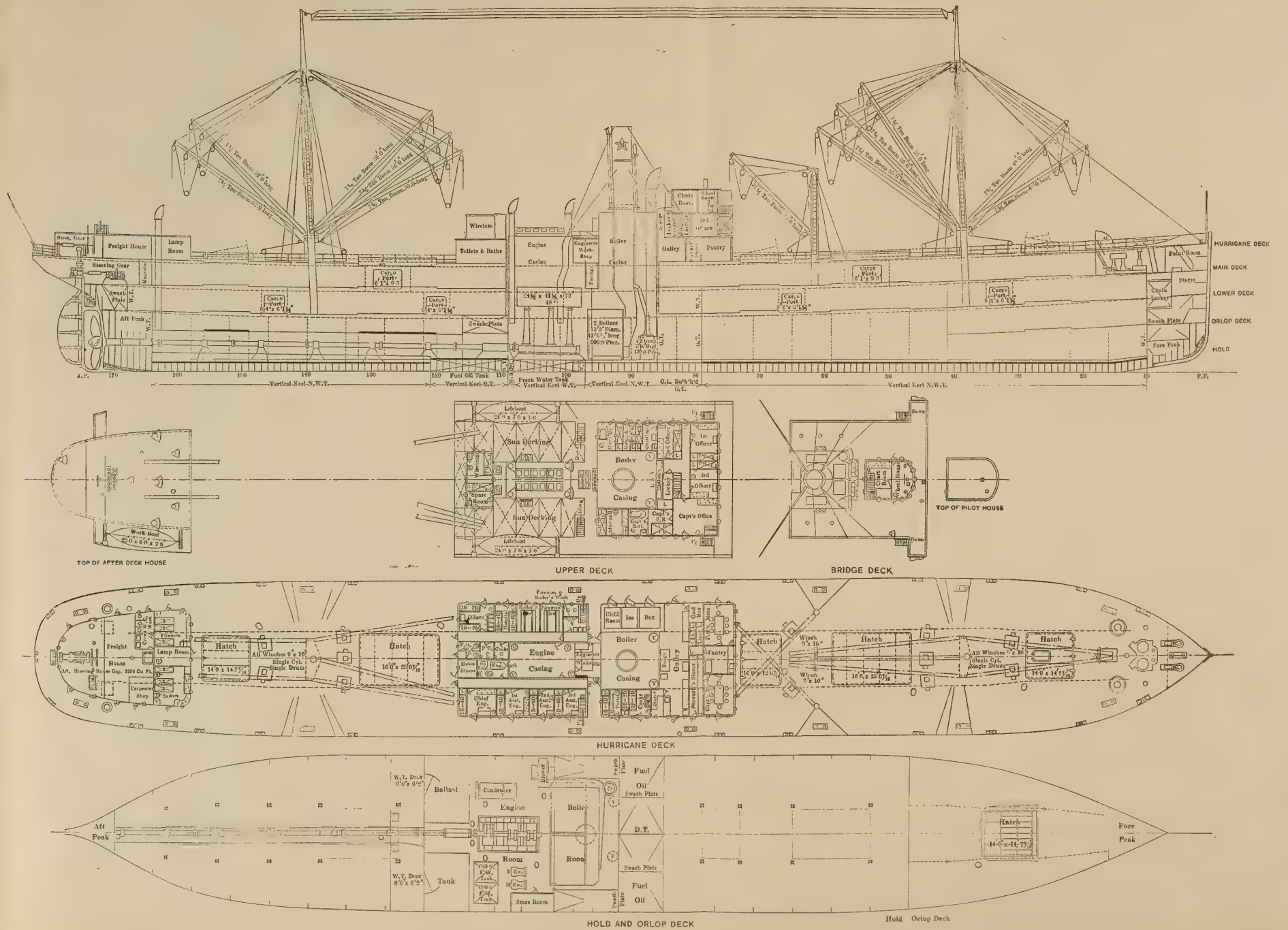


Fig. 2.—Profile and Deck Plans

Water

Sheerstrake 40" x 26
Doubled in Way

Doubled in

Side Plating
inc. 24 lbs.

Doubled in Way

B

NEW SOUTHERN PACIFIC FREIGHTERS

Built by Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

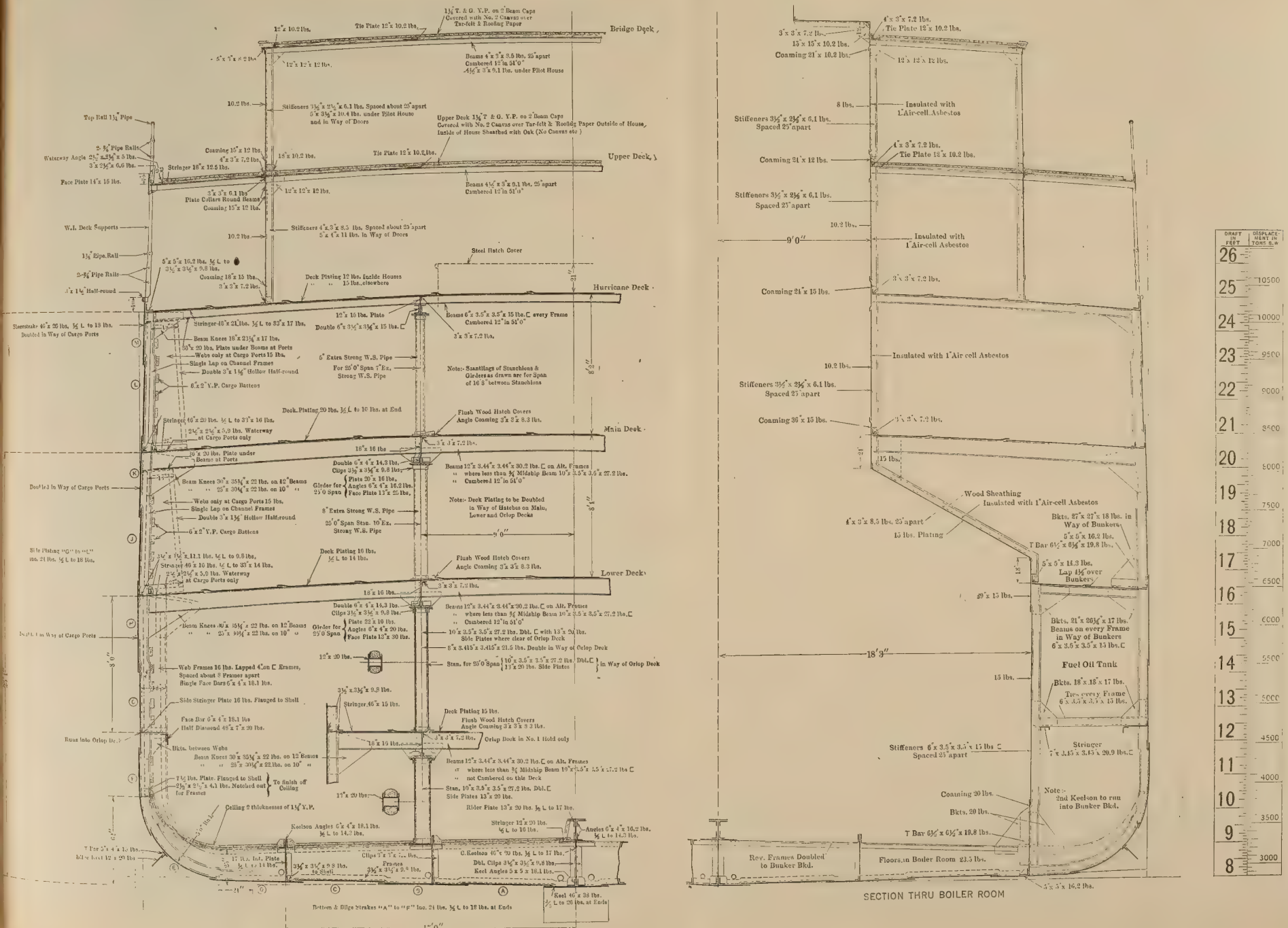


Fig. 3.—Midship Section, Section Through Boiler Room and Displacement Scale

twelve 9-inch by 10-inch friction geared, single cargo winches with watertight frictions. The cargo hatches are fitted with steel covers on the hurricane deck in accordance with the usual practice of the Southern Pacific Company.

Hull Construction

Built on the transverse system of framing, the scantlings of the hull generally are as indicated on the midship section. There is a single flat plate keel and a vertical keel continuous from peak to peak. Watertight bulkheads are fitted at the forepeak, between No. 1 and No. 2 holds, at the after ends of the engine room and ballast tank and at the after peak. These bulkheads extend to the main deck with the exception of the ballast tank bulkhead, which extends to the lower deck only. A watertight bulkhead is also fitted between the lower and main decks over the forward bunker bulkhead. Between the engine and boiler roms around the after end of the boilers a screen bulkhead is fitted.

The stem is a flat bar without rabbet with the lower end fitted with bearding angles for connecting the flat plate keel. The stern frame is a wrought iron forging in one piece with both inner and outer posts extending into the hull and with forged gudgeons.

The rudder is of the single-plate type built up with a forged post having wrought iron frames opposite each pintle, and is connected to separate forged stock by a horizontal flanged coupling. The pintles are of steel with composition casings working in lignum vitæ bushings in the gudgeons. The wear of the rudder is taken by a cast iron supporting collar, made in halves, which bears on a brass ring fitted on top of the main rudder bearing. The main bearing is brass bushed and a brass sleeve is fitted on the rudder stock in way thereof. A cast iron brass bushed bearing with stuffing box is fitted on the hurricane deck.

For about 125 feet amidships bilge keels are fitted consisting of 12-inch by 20-pound plate secured to the hull by a 5-inch by 4-inch tee bar.

The orlop, lower, main and hurricane decks are completely plated over; the upper and bridge decks are fitted with stringers, tie plates and wooden decking.

Throughout the peak tanks, holds and engine and fire rooms the vessel's plating is coated with cement composed of one part Portland cement to two parts of sharp sand mixed with fresh water. The double-bottom tanks under the engine room are coated with two coats of Portland cement wash. The fuel oil compartments are not cemented.

The holds are ceiled with two thicknesses of 1¼-inch first-class quality hard, yellow pine planking arranged with lap joints and fitted in portable sections. The side, bilge and center keelsons are sheathed with hard pine.

Accommodations for the officers are located, as shown on the general plans. The sailors' and firemen's quarters are located in the forward end of the after deck house, while the sailors' and firemen's mess rooms are located in the main house alongside the engine casing. Throughout the officers' and crews' quarters a steam heating system is provided. The heating pipes for the after house are taken from the steering engine steam and drain to the steering engine exhaust and overboard.

The vessel is fitted with a steam steering gear supplied by the Hyde Windlass Company, of the right- and left-hand screw type, with a double-cylinder engine about 8 inches diameter by 8 inches stroke. The steam stearing gear is located on the main deck aft, and is arranged to be operated from the pilot house by steel wire rope transmission connecting to the controlling valve of the engine. A hand gear of the right- and left-hand screw type is also fitted in the after wheel house.

The vessel is thoroughly equipped with drainage, fire, fresh water, ballast, plumbing and salt water systems and is lighted throughout by electricity supplied by two Sturtevant 10-kilowatt, direct-connected reciprocating engine-driven generating sets provided with forced lubrication and operated at 110 volts.

The mechanical telegraphs, located in the pilot house on the bridge and on the warping bridge, are of the Cory double-face type. A McNab direction and revolution indicator is also fitted in the pilot house, indicating the revolutions and direction of rotation of the main engine.

Propelling Machinery

Propulsion is by a single screw actuated by a triple-expansion surface condensing engine with cylinders 24½ inches, 41½ inches and 72 inches diameter by 48 inches stroke, designed to operate at 75 revolutions per minute with steam supplied at a working pressure of 200 pounds per square inch by two oil-fired Scotch boilers 15 feet 9 inches diameter by 11 feet 6 inches long, fitted with a heated system of forced draft. This machinery will enable the vessel under ordinary conditions at sea when running in a free course loaded to a 25-foot mean draft to maintain a speed of 11 knots on a fuel consumption of 1 pound of oil per indicated horsepower per hour.

The main engine is designed with large cylinder ratios, straight ports and low volumetric clearances, in order to produce the highest possible efficiency.

Boilers

The boilers, which are of the single-ended, four-furnace type, with independent combustion chambers for each furnace, are arranged in one fireroom with the furnaces fore and aft. Designed for a working pressure of 200 pounds per square inch, the total effective heating surface of the two boilers is about 6,200 square feet. The boilers are arranged for oil burning only and are fitted with the Howden system of forced draft. The escaping gases, after leaving the heater boxes in the uptakes, pass to a single stack 6 feet 3 inches diameter with a height of about 80 feet above the base line.

The oil fuel burners are of the White patent liquid fuel type, suitable for burning Mexican oil of 11 Baumé gravity. The oil fuel system is provided with three steam oil heaters installed in the discharge line of the oil burner feed pumps. The heaters are designed with sufficient heating surface so that two of them, if necessary, can heat the oil to a temperature of 270 degrees Fahrenheit. Oil strainers in duplicate are fitted in the suction and discharge pipes of the oil feed pumps.

Two fuel oil pumps are arranged in duplicate, piped so that they can draw from either the forward fuel tanks or double-bottom tanks and discharge through the heaters to the oil burners. There is also an oil transfer pump for pumping oil to the various tanks.

Heating coils, consisting of a horizontal bank of 1½-inch wrought iron pipe with return bends, are fitted in each oil tank. The coils are of sufficient area to maintain the oil in the tanks at a temperature of 125 degrees Fahrenheit with the temperature of the outside water at 35 degrees Fahrenheit. The suction pipes to the portable feed pumps of the oil transfer pump are located close together and surrounded by two concentric heater coils, the inner coil about 24 inches in diameter and the outer about 30 inches in diameter, consisting of seven turns of 1½-inch black iron pipe.

Main Engine

The main engine rests on a cast iron bedplate of box form in three sections with cross girders for supporting the main bearings, of which there are six, the four forward bearings being 14 inches long and the two after bearings 16 inches long. The bedplate is held to the foundation by 1¼-inch holding-down bolts of forged steel.

Each cylinder is supported by two cast iron housings of box section, the front housings being straight and the back housings of the A-frame type. The low pressure back housings carry a double bearing for the air pump beams, which are driven off the low pressure crosshead.

The cylinders are of the best quality close-grained cast iron, the high pressure cylinder being fitted with a cast iron liner. Both the high and intermediate pressure cylinders are fitted with piston valves and the low pressure cylinder with a double-ported slide valve. The valve chests on the high pressure and intermediate pressure cylinders are fitted at each end with a working liner, the low pressure valve chest is fitted with a cast iron false face. Balance cylinders with pistons of the ordinary type are fitted to the intermediate pressure and low pressure valve chests, while the low pressure valve is balanced by a balancing ring at the back of the valve.

The pistons are of cast iron, of box type, properly ribbed and fitted with hard cast iron bull rings and followers. The high pressure piston packing consists of strong rings tied by a solid bull ring, and the intermediate pressure and low pressure packing consists of double rings set out by springs.

The piston rods are all of forged steel, 5¾ inches diameter. The connecting rods, also of forged steel, are 9 feet long between centers, 5¼ inches diameter at the top end and 6¾ inches diameter at the bottom end.

The valve gear is of the Stephenson link type arranged so that the cut-off can be varied from 50 percent to 75 percent of the stroke on the high pressure cylinder, while the maximum cut-off on the intermediate pressure and low pressure cylinders is about 72 to 70 percent, respectively.

The main engine is reversed by a direct-acting type engine, 14 inches diameter by 20 inches stroke, while the turning gear consists of a single-cylinder reversible turning engine, 8 inches diameter by 6 inches stroke, located on the low pressure back housing and connected by double worm gearing to the crankshaft. Both the turning and reversing gearing can be operated with 90 pounds steam pressure, although they are sufficiently strong for full boiler pressure.

The crankshaft is 14⅜ inches in diameter, made in two sections. The thrust shaft is of the same diameter, with ten collars, 23½ inches outside diameter. The line shafting is 13¼ inches diameter and the tailshaft 14⅞ inches diameter.

Engine Room Auxiliaries

Steam from the main engine is condensed in a cylindrical surface condenser with cast iron shell ⅞ inch thick and about 11 feet long between tube sheets, containing about 3,700 square feet of cooling surface. Circulating water is forced through the condenser by means of a centrifugal pump with 14-inch suction and 14-inch discharge, driven by a single-cylinder reciprocating engine 8 inches diameter by 10 inches stroke.

Attached to the main engine and driven by beams from the low pressure crosshead are the main air pump of the Edwards type and two bilge pumps.

The other pumps, all of which are special, the details having been modified and approved by the Southern Pacific Company, include:

One main feed, vertical duplex, 10 inches by 6 inches by 15 inches.

One auxiliary feed, vertical duplex, 10 inches by 6 inches by 15 inches.

One fire and bilge, vertical duplex, 12 inches by 7 inches by 12 inches.

One sanitary, vertical duplex, 7½ inches by 6 inches by 6 inches.

One hand oil pump.

Two fuel oil pumps, horizontal duplex type, 6 inches by 4 inches by 6 inches.

One oil supply pump, horizontal duplex, 7½ inches by 9 inches by 10 inches.

The auxiliaries also include a multicoil feed water heater with sufficient surface to heat the feed water to a temperature of 235 degrees Fahrenheit, with a pressure in the heater of from 13 to 15 pounds. A grease extractor is fitted on the discharge side of the feed pump.

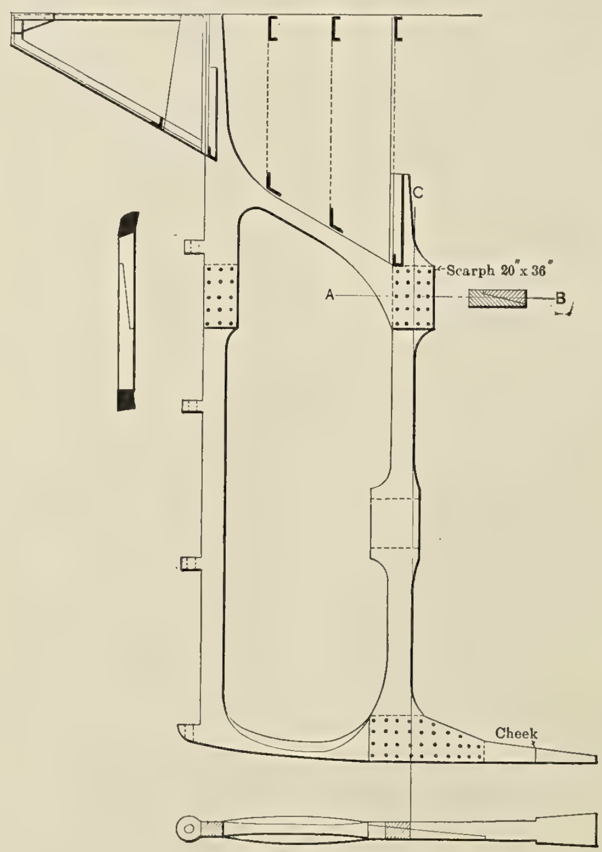
A forced draft blower, designed to maintain sufficient air pressure in the ash pits of the boilers when operating at not more than 300 revolutions per minute, to properly burn the fuel oil, is fitted to take suction from the fireroom space and discharge into the ducts for the forced-draft system. The blower is driven by an inclosed, single-cylinder engine fitted with forced lubrication.

Enlarging Lake-Built Vessels

BY JOHN A. MC ALEER

THE largest vessels that have gone to salt water from the Great Lakes yards via the canals, without being cut in two sections, have been 261 feet overall by 43½ feet beam.

To cut a vessel in two entails considerable expense at



Construction of Stern Frame

both places; nevertheless a larger vessel than the above can be readily built and at no large additional expense. The plan involves the building of the stern frame, according to the accompanying sketch.

The frame is built in three sections, scarphed together as shown. The inner post forms one section, the arch piece with the upper end of the rudder post forms another, while the third will comprise the sole piece and the remainder of the rudder post.

In building the vessel the parts can be bolted together and erected as a unit. The whole after section from the inner post aft will be built and bolted temporarily to the hull proper, together with the upper part of the stern frame. Prior to the launching, the scarphs can be unbolted, the fantail section removed, dummy pieces fitted to fill out the scarphs, and certain of the plates bolted in place.

On the trip down the lakes the after section can be carried on deck and the vessel's motive power could be utilized, the propeller being removed and the tail shaft withdrawn on reaching the locks.

The advantages of this plan will be a vessel that will be perhaps 15 feet longer than the present ones, with an additional deadweight capacity of about 250 long tons. On reaching Montreal, one day in the dry dock should suffice to ship and permanently fasten the different parts.

Balance Weights for Reciprocating Engines

WHEN balancing a four-cylinder reciprocating engine on the Yarrow-Schlick-Tweedy system, the draftsman invariably finds that balance weights must be added to at least two of the crank webs, if a balance would be effected, the moment of the required weight being found by the force diagram. Generally speaking, the shape of the balance weight is such as to render it easy of manufacture, and perhaps the best practice is to include it in the web forging as shown in sketch, Fig. 1.

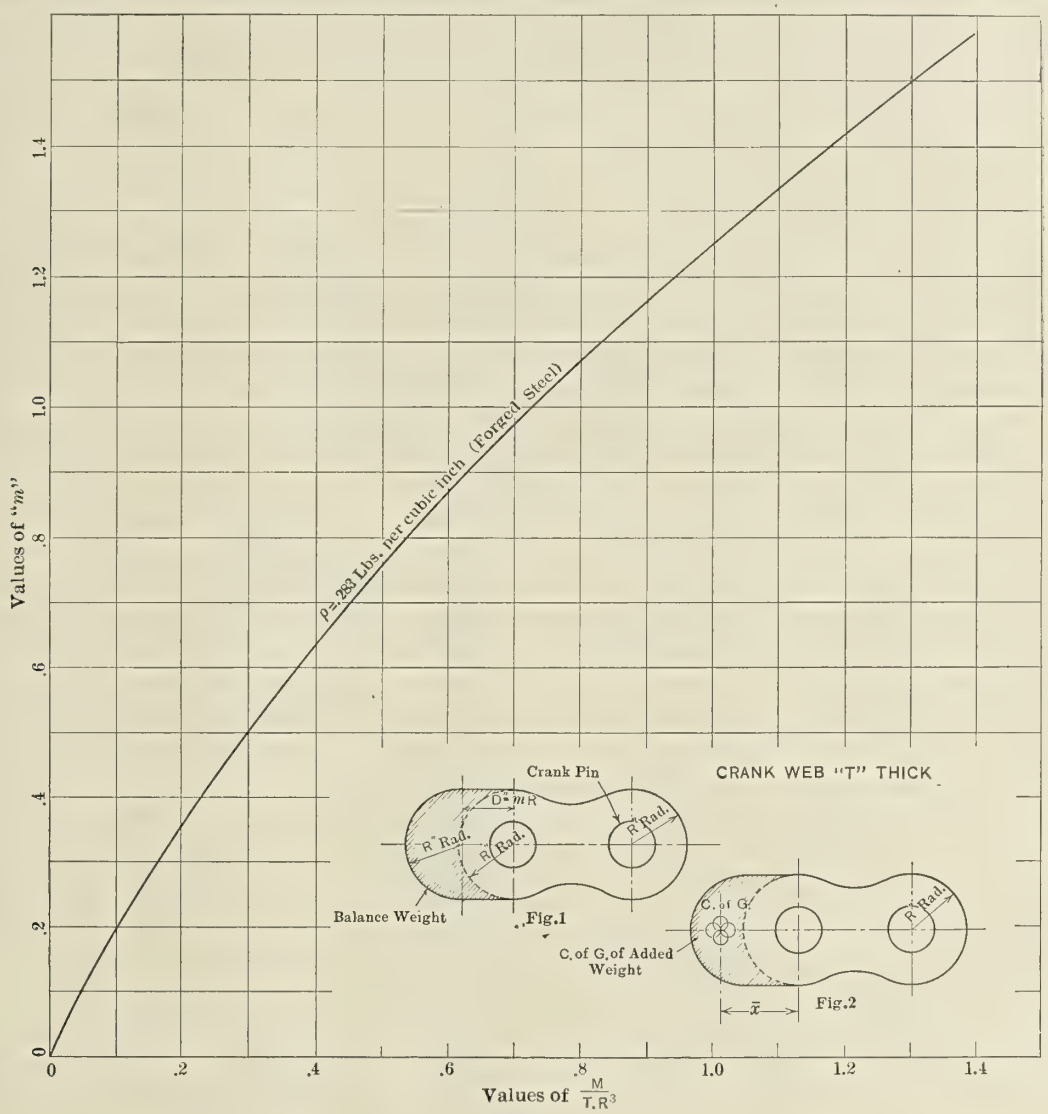


Fig. 3

To fix the dimensions for a weight of this type, in order that its moment shall be equal to that of the unbalanced force, involves both time and trouble if the usual trial and error process be adopted. But by following the method hereafter described such expenditure may be reduced to the minimum:

Let $2M$ = total moment of balancing force, pounds inches,
R = end radii of crank web (see Fig. 1) in inches,
T = thickness of crank web in inches,
D = distance from center line of crankshaft to center from which radius "R" bounding balance weight is struck (see Fig. 1) in inches,
ρ = density of material in pounds per cubic inch.

By equating D with M, T and R (three known quantities)

we are able to find that dimension which immediately fixes the size of the balancing weight.

The result of such an operation gives:

$$D = -\frac{\pi}{4} R + \sqrt{\frac{\pi^2}{16} R^2 + \frac{R M}{T \rho}}$$

But by putting $m R = D$ and plotting m and $\frac{M}{TR^3}$ for a value of ρ previously decided upon, we are able with comparative ease to interpolate a value of m, which will solve the above equation.

An example may serve to illustrate the value of this method: It is found that the balance weights on one crank of a four-cylinder engine requires to have a total moment of 28,980 pounds inches. The thickness of each will be 11¼ inches, while the end radii are 15¾ inches.

Then $M = 14{,}490$,

and $\frac{M}{T R^3} = \frac{14{,}490}{11.25 \times 15.75^3} = .329.$

Interpolating from the curve, we find that when

$$\frac{M}{T R^3} = .329, \text{ then } m = .545$$

$$\therefore D = .545 \times 15.75 = 8.6 \text{ inches.}$$

As a check on the foregoing it can easily be proved that $\bar{x}$ (the arm of the center of gravity of the added weight about the crank axis), Fig. 3, is given by the equation:

$$\bar{x} = R\left(\frac{\pi}{4} + \frac{m}{2}\right)$$

and

$$M = \text{weight added} \times \bar{x}.$$

Duties of Newly-Trained Marine Engineers on Merchant Vessels—II

Taking Charge of and Running the Watch—Details of Scotch and Watertube Boilers—Method of Plugging Tubes

BY C. H. WILLEY

SINCE writing the previous article under the above caption, the writer feels that it was a little brief on the subject, and therefore is submitting a few more pointers for the benefit of those who are entering the marine profession for the first time.

Taking Charge of the Watch

When one engineer relieves another, he accepts the responsibility for the condition of the watch at the time of so relieving. Therefore, if there is reason for refusal to take the watch, the chief engineer should be called below to attend to the matter. If some minor breakdown has occurred, or some incident happened for which it is not deemed necessary to call the chief below, the relief officer can make note of it in the log, and the watch officer will initial it.

The relief officer is expected to put in appearance on the floor plates of the engine room fifteen to twenty minutes before eight bells, or the beginning of his tour of watch duty. This is not compulsory, but will be found good policy. A poor relief, or a tardy one, will soon get in wrong with his mates. Form the habit of getting below early, and satisfy yourself that things are as the engineer of the watch says. Many engineers have the habit of taking the watch over (after hearing the orders that are to be passed along) without making a personal inspection. When one knows that the man he is to relieve is O. K. this may be all right, but the newcomer will do well to see that the bearings are not above running heat, and that oil manifolds, or the lubricating tanks are filled, and drips and feed in proper state.

A running heat on board ship depends on the temperature of the engine room and the conduction of heat from the engine cylinders down through the frame.

See that there is sufficient water in the hot well or feed tanks, and note its temperature. (A good relief will leave the feed tanks pretty well filled and have the temperature as high as possible. This aids the new watch in keeping up steam while cleaning fires.)

Note where the water level is in the steaming boilers, the general condition of the fires, etc.

Find out what valves are open on the steam and feed lines.

Note whether the bilges are pumped, floor plates wiped down, and waste cans emptied.

Read the log to note what has been entered in it since your last watch. Then report to the watch officer that you are ready to relieve him and he will tell you of such special orders that may have been issued by the chief engineer since your last watch. These are generally briefly written in the watch order book of the engine room.

Running the Watch

After taking over the watch, about the first thing to be done is to clean the fires. After cleaning and getting them built up again, the ashes and clinkers are ejected or hoisted. Then the boilers allotted to your watch for tube sweeping should be blown with the steam or air hose.

During a day watch, when ready to sweep tubes, permission should be obtained from the officer of the deck, for if the wind is blowing forward, the soot blown up the stack will settle down over the chart house and bridge. Wind should be abeam when blowing tubes, but if a cargo steamer, this rule does not apply.

The watch officer should make a round of the bearings of both the main engines and the auxiliaries about once an hour, to feel them. While making these rounds, he should note the condition of the oil and water service, look for loose oil cups, pipes, bolts, etc. When feeling for the moving parts, considerable dexterity is required, and one has to make sure of his footing, for the ship may make a sudden roll and catch one off guard.

A creamy, pale, yellow thin lather coming from the ends of a bearing indicates that it is running fine. At

low speed it has been found beneficial and economical to mix a bucket of soap solution, or wash, consisting of one-half bar of fine grade yellow soap, three-fourths bucket of water, and one quart of oil, and occasionally feed a little to each bearing; this washes out the bearing. It should then be followed up with clean oil.

The piston rods and valve stems, when running well, should present a bright polish; to get them in this condition they must be swabbed with a mixture of heavy cylinder oil and graphite about once an hour. A hot rod will turn the oil on its surface black or dark blue, and is readily detected by the smell of burnt oil. When a rod is running hot, it must be freely slushed with a squirt gun filled with soap solution, and intermittently swabbed with a tar brush. The oiler should stand by the hot rod until it is cooled.

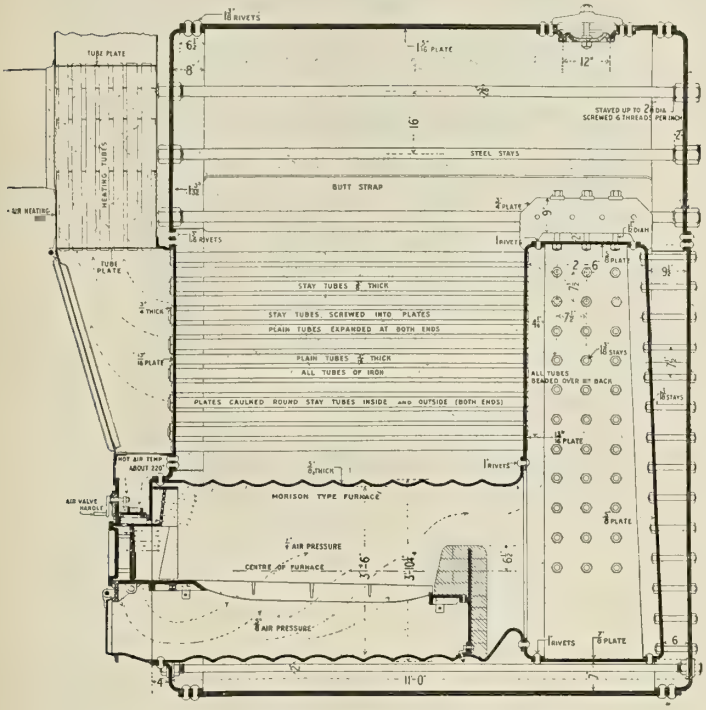


Fig. 1.—Section Through Scotch Boiler

Never under any conditions allow water to be supplied by a hose—this is dangerous; it will crack the rod or bend it and result in an accident.

If the gland can be safely slacked while running, it should be done; but if this is not possible, then the engine must be slowed or stopped till the trouble is cured.

The bridge must be notified of any pending trouble in the engine or firerooms in order that they may be prepared to handle the ship, should it be necessary to stop.

The thrust bearing calls for special attention at speeds above half power; the collars of a thrust shaft are guided between what are called thrust block shoes. These shoes are babbitted on both sides, and on these faces of babbit oil grooves are cut, which are connected to the oil cup or trough on the top of the shoe. The shoe is cored hollow and sea water is circulated in it through pipe connections. Generally the bottom part of the thrust bearing bed is formed into an oil-tight compartment and the collars of the shaft revolve in this.

Should the ship be required to tow another, then the strain on the thrust shoes becomes greater. This is true when running against strong head winds or currents.

When filters or grease extractors are installed in the feed lines, they are generally cleaned on the 4 to 8 A. M. watch. If this be your watch, see that they are well cleaned, for oil is dangerous in the boilers.

The watch officer should visit the firerooms quite frequently to see that coal is being burned properly and fires in good condition. The dead plates at the furnace should be kept clear of live fire.

See that the water level is at the proper height and the try cocks are tested. The newcomer must remember that on long rolls or plunging of the ship the water level is altered, and to get the true level one must watch the glass carefully for a few seconds.

In feeding a battery of boilers, the feed checks or stops should be so regulated that each boiler in use gets its regular supply of water. Should a man allow his boiler to run low, and he opens his feed supply wide, he endangers the other boilers, for they cannot get their allowance.

See that the firemen are using the dampers correctly and breaking up all large lumps of coal before firing, and that large clinkers are not allowed to lay in the fire.

Test the feed water for salt during your watch. (There is generally kept on the engine room desk a small bottle of silver nitrate solution.) A sample of the boiler feed is taken in a clear bottle, and with an eye dropper a few drops of this solution is put into the sample of feed water. If salt is present, it will turn the drops of silver nitrate to a milky appearance.

When salt is found, the saline contents of the water should be ascertained and entered in the log. The chief engineer is notified and will issue directions about blowing down of the boilers to reduce the saturation.

Make entries of all happenings in the steam log. Fill out all the data called for under each heading on the log.

Have everything wiped down, bilge strainers cleaned and bilges dry, and all things in shipshape for your relief. If anything has gone wrong, or things are not in condition to turn over to your relief, the watch should remain on until things are put right, or the relief is willing to take the watch.

Marine Boilers

A brief outline of the fire and watertube types will aid the newcomer. The old Scotch boiler continues to be

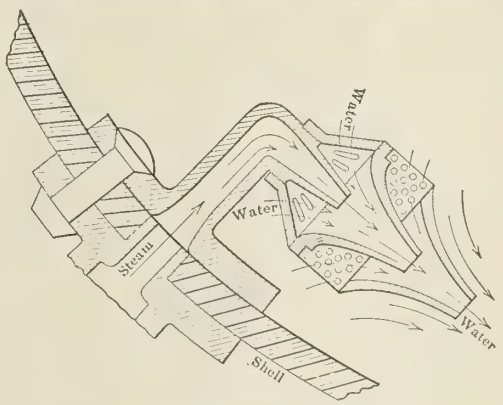


Fig. 2.—Hydrokineter

widely used for cargo and merchant vessels. A sketch of a familiar design is given in Fig. 1. This is known as a single-ended three-furnace type. There are also double-ended Scotch boilers (furnaces and combustion chambers in each end). Practically they are as two single-ended, placed with back to back and riveted together with the rear sheets or heads removed. Each furnace has its own combustion chamber and nest of tubes.

On account of the large body of water contained in the shell of the Scotch boilers when raising steam, the water

has to be agitated or circulated to facilitate the work and save time. When fitted with a hydrokineter, as shown in Fig. 2, the water is circulated by supplying it with steam taken from another boiler. When no hydrokineter is fitted, the water can be circulated by a feed pump, taking from the bottom blow connection and pumping back through the feed checks.

When starting fires the wing furnace fires are lighted off first to aid circulation. It requires from eight to ten hours to raise steam to working pressure in Scotch boilers. It can be done in less time, but injury is liable to result from rushing a cold boiler into service.

It is possible to plug a leaky tube in this type of boiler while steaming. One form of leak stopper is shown in

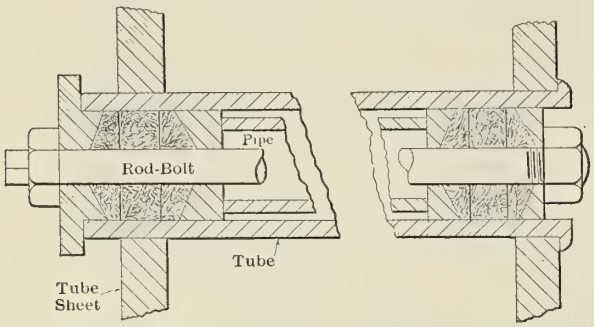


Fig. 3.—Fire Tube Leak Stopper

Fig. 3, consisting of a through rod, four cup washers or packing plates, and a piece of steel tubing or pipe. The placing of this leak stopper is a hot, uncomfortable job, and has to be done quickly. The packing washers are cut a little smaller in diameter than the inside of the tube, and when the device is in place a wrench is used on the square of the front end of the king bolt and the nut set up as tight as possible. This squeezes the packing out against the inner walls of the tube, making a tight joint.

Watertube Boilers

Stationary men are better acquainted with the watertube boiler than with the Scotch or fire tube, but there is considerable difference in the setting and construction of the land and marine type of watertube boiler. The Babcock & Wilcox and the Heine safety boiler are the two most widely adopted for marine use. The Stirling, and also Ward, boilers are constructed along somewhat the same lines. A description of the Babcock & Wilcox will serve to acquaint the newcomer with this class of boiler.

The watertube boiler is used on almost all vessels of our Navy, while hitherto but few merchant ships have had them. (Recently a large contract was awarded to the Heine Boiler Company to fit out ships now building with their type of tube boiler.)

Fig. 4 shows a section through one of the latest types of Babcock & Wilcox boiler. This is equipped with a superheater. The path of the hot gases is shown, as are also the lanes of water circulation. The B. &. W. is known as one of the free circulation class. The tubes incline from front to rear 15 degrees from the horizontal. The circulation is as follows: Starting from the drum through the downtake nipples to the front headers, thence through the 2- and 4-inch tubes to the back headers, up through these to the 4-inch circulating tubes, through which it returns as steam and water to the drum.

The tubes that form the heating surface are arranged in separate vertical elements. Each section is made up of a series of straight tubes expanded at each end into wrought steel headers of corrugated pattern. This form

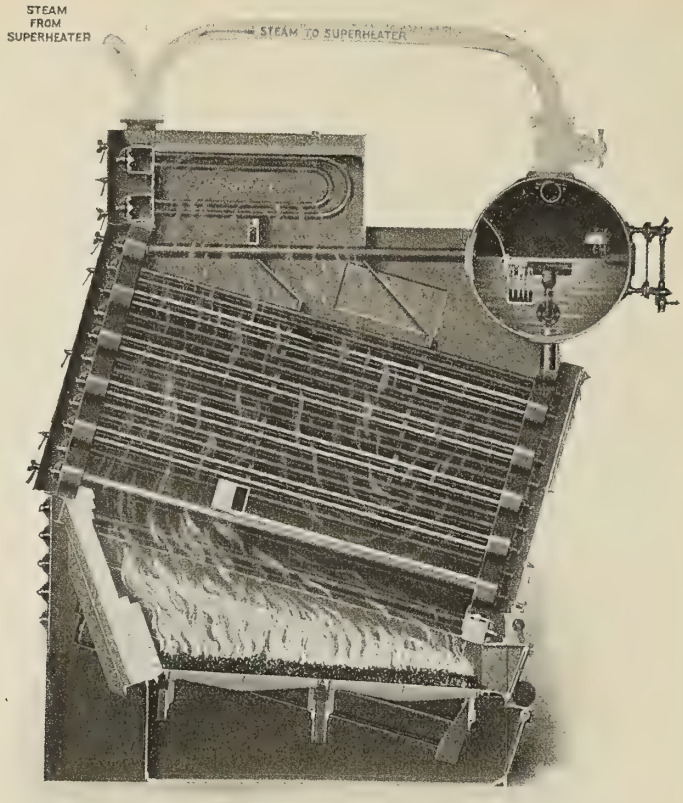


Fig. 4.—Section Through Babcock & Wilcox Watertube Boiler with Superheater

of header staggers the position of the tubes, which completely distributes the hot gases over the entire heating surface.

Extending across the front of the boiler and connected to the lower ends of the headers by 4-inch nipples are two separate wrought steel boxes known as mud drums. At the lower sides and in the center, 6-inch square section wrought steel side boxes are installed. These are connected to the uprights, and these in turn to the headers. These boxes are filled with water, which serve

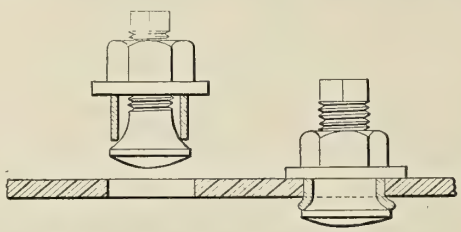


Fig. 5.—Tube Hole Plug for Watertube Boiler

to absorb the heat and aid the rapid steaming of the boiler.

Should a tube be found defective, it may be renewed or temporarily plugged, for both ends of the tube are accessible by removing the handhole plates of the header near the injured tube. For plugging tubes, a tapered plug is used, in the large end of which is drilled and tapped a hole for a screw bolt. This provides a means for removing the plug.

When it becomes necessary to remove the tube, and no new ones are at hand to install, a tube hole plug, as shown in Fig. 5, can be readily installed.

(To be continued.)

Development of Machinery in the United States Navy During the Past Ten Years*

Trials of Delaware and North Dakota, and Experience with Oil Fuel—Turbine-Driven Blowers—Cruising Economy in Battleships

BY CAPTAIN C. W. DYSON, U. S. NAVY

In the contracts for the *Delaware* and *North Dakota* appeared for the first time a requirement for the measurement of the steam used, this for the *North Dakota* being accompanied by guarantees that the following steam consumptions per shaft horsepower would not be exceeded:

Full speed	15.1 pounds
19 knot	16.1 pounds
12 knot	23.2 pounds

The *Delaware's* trials took place off Rockland, Maine, in October, 1909, and those of the *North Dakota* off the same place in November of that year. The results obtained were:

Ship.	12-knot.		19-knot.		Full speed.	
	Del.	N. D.	Del.	N. D.	Del.	N. D.
Speed	12.24	12.04	19.217	19.21	21.56	21.64
Indicated horsepower (main engine)	3,905	.....	16,602	.....	28,578	.....
Shaft horsepower (main engine)	.....	3,757	.....	16,713	.....	31,862
Coal per indicated horsepower or shaft horsepower	2.673	2.64	1.795	1.63	1.888	1.71
Water per indicated horsepower or shaft horsepower	19.37	27.12	13.91	16.67	14.32	14.

In advertising the results of this first large Curtis turbine installation, the advocates of the turbine in comparing the two vessels religiously confined themselves to the comparison of coal per horsepower, and always called your attention to the fact that a shaft horsepower was only 92 percent of an indicated horsepower, and that, therefore, the fuel consumptions were:

	12 Knot	19 Knot	Full Speed
Delaware	2.9 pounds	1.95 pounds	2.05 pounds
North Dakota	2.64 pounds	1.63 pounds	1.71 pounds

per shaft horsepower, thus indicating the vastly greater economy of the steam turbine and its therefore much greater superiority as a marine engine.

They carefully neglected, however, to call attention to the following comparison, which gives the measure of the relative propelling efficiencies of the two types of machinery:

	Total Pounds of Water		
Speed	12 Knots	19 Knots	Full Speed
Delaware	83,463	243,810	422,931
North Dakota	101,883	281,784	445,979

These figures, which glaringly demonstrated the superiority of the reciprocating drive as compared to the then current turbine practice, have been maintained and even increased by the *Delaware* in service as the efficiency of the *North Dakota's* turbines rapidly decreased, while at the same time the turbines became unreliable, finally necessitating her withdrawal from active service with the fleet until new machinery could be built and installed.

Destroyers of 1906

No torpedo boats or destroyers had been appropriated for since the completion of the first lot of sixteen destroyers, which had occurred in 1901-1902, these having been authorized in 1898 and having taken from three to four years for completion.

These original destroyers were of about 7,500 I.H.P., and were designed for 28.5 knots, trial speed. After many difficulties and a reduction of trial speed to 27.5 knots they were finally squeezed through and accepted. Great troubles were experienced with their light and fast running reciprocating engines, and with their forced draft blowers, which were also driven by reciprocating engines.

In 1906 and 1907 five more destroyers were authorized. The estimated I.H.P. for this speed was 10,000, and the Navy Department prepared plans showing the use of reciprocating engines for this power. In advertising for bids for the construction of these vessels bidders were invited to submit plans showing turbine machinery both with and without cruising turbines, and were given to understand that, other things being equal, turbine installations would be preferred.

These vessels as finally contracted for were all of three-shaft Parsons turbine type with a H.P. and I.P. turbine, one on each outboard shaft, for cruising purposes. The vessels were all coal burners, and while, during their construction, it was proposed to change to oil fuel, the cost of change and the difficulties in the way due to progress of construction were found to be so great that the idea was abandoned.

There never was any doubt in the mind of the department as to the desirability of displacing the unreliable high speed engines that had been previous practice for these light high speed vessels by the more reliable turbine, and the step was taken with no hesitation. There was also another step in advance made at the same time, and this step was even of more value, if possible, than the adoption of steam turbines for the main propelling engines.

Steam Turbine-Driven Blowers

One of the great sources of failure to hold high speed for any long continued period of time with all classes of vessels had been the continually recurring breakdowns of forced draft blowers with engines of the reciprocating type. These had been done away with, and blowers driven by electric motors substituted for battleships, beginning with the *Michigan* and *South Carolina,* as already stated.

In two of these five destroyers appeared for the first time the turbine driven, forced draft blower. In laying down the plans for these vessels the Bureau of Steam Engineering had scanned the market closely to find turbine driven blowers of proper design to install for the work required. Not being able to find any such in existence it invited in the specifications the installation of such type in place of the type directly specified. Meanwhile it succeeded in awakening the interest of the Terry Steam Turbine Company in the proposition, and by the time the contracts for the construction of the vessels were awarded this company had developed what appeared to be, on paper at least, a very satisfactory unit.

The Cramp Ship and Engine Building Company were

* Reprint from the Journal of the Society of Naval Engineers, continued from November issue.

quick to see the advantages in this new unit, and proposed its installation in the two vessels building by them. This proposal was approved and the units installed. The contractors for the remaining three vessels, however, adhered to the old reciprocating engine blowers, arguing the greater steam cost with the small, inefficient turbines, losing sight, however, of the fact that with feed heaters installed and with turbine main engines in which excess auxiliary steam can be used in the heaters and in the low pressure stages of the turbines, steam economy of auxiliaries only used when the main engines are in operation or used to only a small extent in port, does not cut any great figure in the general economy of the machinery plant. Also that the greater reliability of the turbine blowers would, if realized, more than offset any possible loss in economy, as the forced draft blowers, in rate of importance to a destroyer, are as necessary as a good heart is to the human body.

The blower units as fitted were of the vertical, direct connected turbine type, with single stage Terry turbines driving what are known as multivane fans of the Sirocco type. These fans are located directly at the base of the intake ventilators and discharge throughout their complete circumference into what is called a diffuser chamber, in which the velocity of the discharge becomes reduced and the air pressure after discharge from the fans increased.

The diffusion chamber is formed by two plates forming frustums of cones with the bases separated several inches at the outer circumference; the inner edges of the plates at the fans being separated to the width of the fan blades.

When the vessels carrying the new type of blowers were tried great trouble was experienced, due to two fans discharging into the same fireroom; unless the fans were running at practically the same speeds, that fan which was doing the least work would be wrecked on account of the air being forced back through it. After considerable trouble and experiment, the cause of the trouble was located. It was due to the too great width of discharge opening from the diffuser chamber. This error was corrected and the fans by their later performances instilled such confidence that no other type of blower than that of the turbine driven has since been considered for destroyer work, and in later vessels of other types it has even shouldered the electric driven fan out of the way, as the flexibility of control is so much greater.

Experience with Oil Fuel on the Delaware and North Dakota

The oil fuel handling of these two vessels varied in one respect, and that was in the location of the settling tanks, that of the *Delaware* being located aft alongside the engine room, while the *North Dakota* followed the bureau plans and had a small cylindrical tank located in the upper part of each fireroom. This location on the *North Dakota* was later credited with a disastrous fire on that vessel in which several lives were lost. The real cause of the disaster was, however, the fact that each of these tanks was fitted with a glass gage for indicating the height of oil in the tank, and oil vapor having collected on the flat tops of the Babcock & Wilcox boilers, it became ignited in some unknown manner, the flash resulting broke the gage glass and, the booster pump supplying oil to the tank being running at the time, the oil was forced out and burned like a gigantic torch until the pump was stopped and the tank completely emptied.

Orders were immediately issued by the department prohibiting the use of gage glasses on oil fuel tanks unless such glasses were fitted with spring valves that were open only while readings were being taken, the valves closing automatically when released.

Other troubles were experienced with the oil fuel due to the inexperience of all hands concerned with it, including the makers of the oil fuel apparatus. The burners as originally supplied were of sufficient capacity to deliver the full power condition, and this, on account of insufficient volume of furnace above the grates, resulted in heavy carbonization on the grates and bridge walls and in very heavy smoke formation. All manner of criticism was leveled at the system employed, and it was only by taking a strong stand on the subject that the bureau prevented it from being superseded by air or steam atomization. The succeeding years have demonstrated the wisdom of the step, and we hear no more of propositions to use any other system.

1907-1908

The next naval appropriation bill provided for two battleships of the dreadnaught type and for ten destroyers.

The battleships, later named the *Florida* and *Utah,* were very similar to the *Delaware* in hull lines, but of about 1,000 tons greater displacement, requiring a slightly greater towrope power at low speeds and slightly lower towrope power at 21 knots than was required for the previous vessels.

In laying down the machinery arrangement plans, the fireroom arrangement of boilers and piping was practically duplicated, the boilers, however, being slightly increased in heating surface over the total heating and superheating surface of the earlier vessels, while no superheaters were installed, the Parsons marine turbine not being adapted to use superheated steam on account of the abnormally small radial blade clearances which must be provided in that turbine in the high pressure stages in order to preserve, or rather realize, a good efficiency.

Following the British lead, the engine rooms were laid out showing a four-shaft installation of Parsons turbines with H.P. turbines, both ahead and astern, on the outboard shafts, and L.P. ahead and astern turbines on the inboard shafts. The inboard shafts likewise carried cruising turbines, a H.P. turbine on one and an I.P. turbine on the other, so that at low speeds the steam would just pass through the H.P. cruising, then the I.P. cruising, thence to both H.P. mains, finally through both L.P.'s to the condensers. At intermediate speeds it was admitted to the I.P. cruising direct, the H.P. cruising running in vacuo. At higher speeds both cruising turbines were cut out and ran in vacuo.

Necessity for Cruising Economy in Our Battleships

When the conditions under which our battleships must operate are compared with those which faced European nations in the period directly preceding the present great war, a war which they all evidently had in mind in the preparation of the machinery designs for their vessels, it is readily understood why they could afford to neglect any provisions for insuring great cruising radius, while with us the necessity for providing the maximum cruising radius is imperative.

The former nations were providing for operations in confined waters such as the North Sea and the Mediterranean, where they were never far from their bases. The runs from base to station were short, and occasion might arise where these runs would have to be made at high speed. Refueling became a simple proposition. Under the conditions foreseen, high speed was more desirable than cruising radius, and the latter was sacrificed.

Turning now to the conditions confronting us we see the entire western half of the North Atlantic ocean from the northern shores of South America to Greenland on our eastern sea front, and the entire line from Seattle to Panama to the southward, and from Seattle to Honolulu, thence to Guam and on to the Philippines, and still further to Samoa, requiring our attention. The areas to be covered are great and the distances to bases and from base to base in some cases are magnificent. Fuel economy is of the highest value, even predominates over high speed, as the refueling problem becomes a serious one and the greater our bunker capacities and the greater the fuel economy of our machinery, by so much is the seriousness of the problem reduced.

It will be shown later how this question had an important bearing on the decision of the department as to the types of machinery to be fitted in some of our subsequent vessels.

Beyond the installation of Parsons turbines in these two vessels, the only point of practical engineering interest was a change in the basis of design of feed heaters. The old empirical rule used for years in the design had been to allow one square foot of heating surface for every ten designed I.H.P. Such a rule took no account of the amount of heating medium, which in the case of naval vessels is the auxiliary exhaust steam, the temperature of the heating medium, nor of the amount of feed water to be heated. During the year preceding the designs of these vessels the Bureau of Steam Engineering had developed a feed heater which, when constructed, had been thoroughly tested out at the Engineering Experiment Station under conditions of exhaust pressure and temperature corresponding to those used in service. From the results of these tests design curves were prepared, and from these curves the necessary surface for the feed heaters was obtained.

In connection with these tests comparative tests were made with and without whirler strips in the tubes, these whirler strips being nothing but ribbons of sheet copper twisted to a pitch of 6 inches and inserted in the tubes, extending their full length. These whirlers, by causing every particle of water flowing through the tube to be brought into intimate contact with the heating surface, increased the efficiency of the heater about 25 percent.

The heaters developed from the design curves required a total heating surface for both heaters, inclusive, of 700 square feet, while those of the preceding vessels under the old empirical rules required 2,100 square feet.

In service the new heaters, paradoxical as it may seem, have done much better work than the old ones, delivering the feed at considerably higher temperatures and eliminating the constant troubles of leaky joints that had formerly been experienced.

I am giving the above as an illustration of the beneficial results that may be expected, both in small and in large problems, by carrying out a series of well thought out experiments, and am happy to be able to say that this is only one of the many instances where the Engineering Experiment Station has demonstrated its value to the Bureau of Steam Engineering and through it to the naval service in general.

Of the ten destroyers, two were fitted with Curtis velocity compounded turbines on two shafts, two with Zoelly turbines of a similar type, and six with Parsons turbines on three shafts. The Curtis and Zoelly turbines were newcomers in the destroyer field in this country, but from reports received at the time, the Zoelly turbine was in successful operation in the German navy. When these vessels were completed and put into active service, those with the Curtis and those with the Parsons turbines gave satisfaction from the very start. In a short time, however, the vessels fitted with the Zoelly turbines demonstrated that either our information from abroad as to the success of this type of turbine was incorrect or that the American builders did not understand its construction sufficiently well to build a good turbine. Both vessels gave trouble, but while these troubles appear to have been practically conquered in one of the vessels, in the other the turbines went from bad to worse, and are now being replaced with machinery of a different type.

The Navy Department, with these vessels, definitely adopted oil as the approved fuel for destroyers, the system adopted being that of "pressure atomization," commonly, though erroneously, known as "mechanical atomization." The air for combustion was supplied by turbine driven blowers of the open type, this type of unit having come to stay.

These being the first installations of all oil fuel, they became the school of experience from which many practical points in handling oil fuel were learned. Among these may be mentioned the following as being practically basic necessities for successful fuel oil burning:

1. Steady pressure in oil fuel supply lines to burners.
2. Burners which will efficiently atomize the fuel and, for boilers of the express type, throw a long flame.
3. High and steady air pressure in the firerooms, which prevents leakage of unburnt gases through the boiler casing joints into the firerooms and also provides a life insurance for the fireroom force by preventing flare backs of flame and blow backs of steam in cases of tube rupture.
4. High velocity of air entering furnaces to insure intimate mixture with atomized oil throughout length of flame, thus preventing wreckage of furnace linings by heavy pulsation.
5. Efficient and large areas of fire brick furnace linings, well secured, to prevent radiation losses and to increase furnace efficiency.
6. The absolute necessity of so locating oil burners that no unburnt oil can come in contact with boiler tubes or fire brick lining of furnace if smokeless burning is to be obtained and if the building up of heavy carbon deposits is to be avoided.
7. Ample air supply to insure an excess of air when running at full power, as this excess is necessary to insure smokeless combustion.
8. Avoid relatively high gas pressures in the boiler passes and uptakes, as such pressures render furnace conditions unstable and tend to produce pulsation, with consequent destruction of furnace linings.

(*To be continued.*)

Annual Meeting of Institute of Naval Architects

The next annual meeting of the Institute of Naval Architects will be opened in London on March 20, 1918.

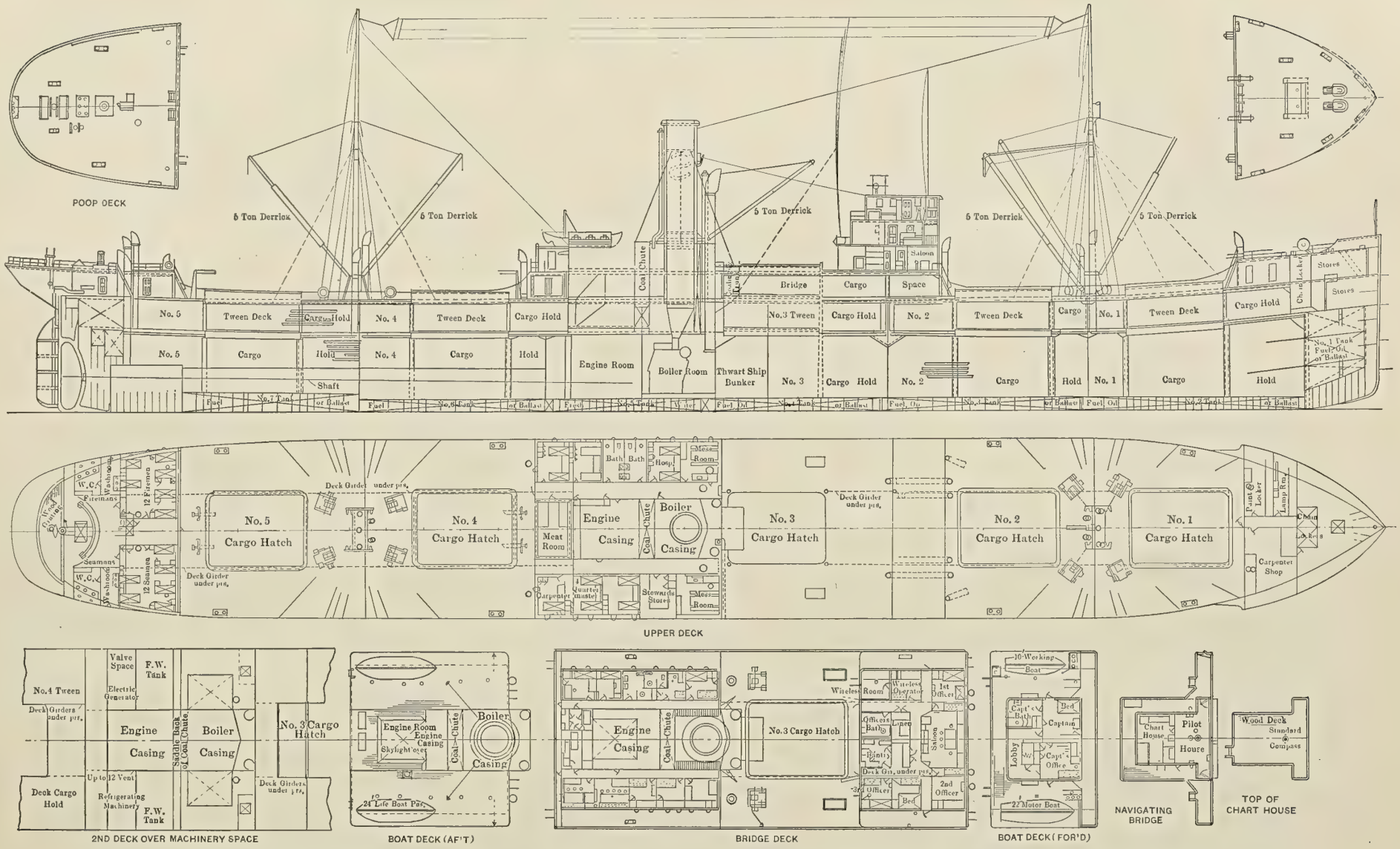
Annual Meeting of American Society of Mechanical Engineers

The thirty-eighth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, December 4-7. The dominant theme of the meeting will be The Engineers' Part in the War and an entire day will be devoted to a discussion of the service of the engineer to the public in times of crises.

At the opening session honorary membership will be conferred upon Major-General George W. Goethals and the meeting will be addressed by Hon. William H. Taft, ex-President of the United States.

GENERAL ARRANGEMENT PLANS OF FABICATED STEEL CARGO SHIP

By Chester Shipbuilding Company, Ltd., and Merchant Shipbuilding Corporation, Chester, Pa.



Profile and Deck Plans of Vessel 401 Feet Long, 54 Feet Molded Beam, 32 Feet 9 Inches Molded Depth and About 8,800 to 9,000 Tons Deadweight Carrying Capacity.

Fabricated Ships*

Methods of Construction Developed by Chester Shipbuilding Company

BY R. H. M. ROBINSON

RECENTLY the term "fabricated ships" has become one of public interest. A fabricated ship may be defined, briefly, as a ship on which the work of punching and shaping the plates and shapes and, to some extent, assembling and riveting, is done in a fabricating shop, ordinarily employed for bridge or tank work, as distinguished from the usual practice of doing it in a shipyard punch shop.

So far as the writer knows, the fabricated ship is a product of American progressiveness. The principal credit for carrying out the fabricating idea is due to Mr. C. P. M. Jack, now consulting engineer, and to Mr. Max Willemstyn, engineering manager of the Chester Shipbuilding Company and of the Merchant Shipbuilding Corporation, and it would be improper to neglect to state that the ideas of Messrs. Jack and Willemstyn could probably not have been carried out except for the interest and assistance given them by Mr. Jas. A. Farrell, president of the United States Steel Corporation, and by the officials of the American Bridge Company.

The construction of fabricated ships makes it possible to have the steel work done by those who are specialists in the line of fabricating steel with all of the special tools and labor-saving devices at their disposal. It relieves the mind of the shipyard operator from the multitude of detail that goes with such work, reducing his problems to those of engineering, erection, riveting and assembling by the workmen, and to the installation of other units of outfit and equipment.

Ship Shapes and Plates to Be Used

The type of ship which the Chester Shipbuilding Company has built, and which it and the Merchant Shipbuilding Corporation are now building, provides for the use in all places of conventional ship shapes and ship plates, subject to the rules, inspection and survey of the registration society, both as to quality and material, dimensions, riveting and other matters. These vessels are cargo carriers of about 8,800 to 9,000 tons deadweight capacity with poop, topgallant forecastle and bridge, the latter being about 124 feet long. The decks, with the exception of the poop and topgallant forecastle, are without sheer at the center line. Complete double bottom for the carrying of fuel oil or water ballast is fitted. The machinery is located amidships and consists of high and low pressure turbines, driving a single screw through reduction gears.

In the emergency which has recently arisen there have been proposed ships constructed from bridge shapes and universal mill plates, with regard to which the writer has no personal detailed knowledge. It would appear to him that there might arise certain difficulties in using this character of material in the construction of ships, but he would prefer to leave to those who are personally cognizant of the matter any questions in regard to this.

The manufactured ship is a commercial possibility only if duplicate ships are built and, therefore, this policy was adhered to as far as possible from the beginning in contracting for the ships at Chester, there being but four different classes. These classes are as follows:

Types of Ships

1. Tank ship of about 9,000 tons deadweight capacity, fitted with cylindrical tanks on Jack's system. The vessel is built with topgallant forecastle, poop and short bridge. The main deck at centerline and top of expansion trunk are without sheer. Cylindrical tanks extend from tank top to under side of main deck, and a continuous trunk extending between poop and topgallant forecastle takes care of expansion and provides a working deck between the bridge, poop and forecastle decks. Machinery is located aft and consists of a high and low pressure turbine driving a single screw through reduction gears.

2. Two-decked freighter of about 8,800 to 9,000 tons deadweight capacity having poop, topgallant forecastle and bridge, the latter being about 124 feet in length. This vessel is built with sheer. Complete double bottom for the carrying of fuel oil or water ballast is fitted. Machinery is located amidships and consists of high and low pressure turbines driving a single screw through reduction gears.

3. Shelter-deck freighter of about 9,300 tons deadweight capacity, having poop, topgallant forecastle and bridge. Complete double bottom for the carrying of fuel oil or water ballast is fitted. Machinery is located amidships and consists of high and low pressure turbines driving a single screw through reduction gears.

4. Two-decked freighter of about 8,800 to 9,000 tons deadweight capacity, having poop, topgallant forecastle and bridge. The decks, with the exception of the poop and forecastle decks, are without sheer at the centerline. Complete double bottom for the carrying of fuel oil or water ballast is fitted. Machinery is located amidships and consists of high and low pressure turbines, driving a single screw through reduction gears.

Except as to details which may be modified to provide for ease of fabrication, the fabricated ship does not differ essentially in structure from any ship of a similar class. One of the prime questions involved is that of multiple punching.

Multiple Punching

The greatest difficulty with the arrangement for multiple punching lies in the fact that the minimum distance from center to center of punch dies in a multiple punch is regularly 2 inches, which distance can occasionally be reduced to 1⅞ inches.

The term "multiple punch" implies that the spacing of rivets is to be laid out so that the spacings of rivets in different successive rows are in multiples of each other or in multiples of 2 inches. Take for example a butt spacing of four diameters of ⅞-inch rivets equal to 3½ inches. The frame riveting in this case could be six diameters or 5¼ inches, which is no multiple of 3½ inches, and neither is 3½ inches a multiple of 2 inches.

A compromise is made in this case by making an average butt-spacing of 3½ inches, which can be done by spacing in groups of three, viz., 3¼ inches, 4 inches, 3¼ inches. The punches for the butt and frame spacing would be spaced in the machine as follows: 3¼ inches, 2 inches, 2 inches, 3¼ inches. The first, second, fourth and fifth punches would be used for the butt-spacing. The first,

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1917.

third and fifth for the frame spacing allowing for a 5¼-inch spacing.

Where the butt-spacing is 3½ diameters and the frame spacing 7 diameters, such as on smaller size ships, there is not much trouble, but the multiple punch is hardest to apply on the 9,000-ton, clear-hold, single-deck ships, with their 5½ and 6 diameters frame riveting. Again, on the larger ships with 4-inch butt-spacing it is easier to be according to rule, and it should be here noted that Lloyd's Register of Shipping has been very progressive and broad-minded in allowing the use of the average spacing instead of the strict and absolute adherence to stated rules.

The first thing to do on a ship designed for multiple punch is to arrange the midship section in such a way that all longitudinal rows of holes fall in line with the principles just explained; second, to arrange the plate width so that the greatest number of equal width plates are obtained; third, to see that, if possible, each plate is symmetrical about the long centerline of the plate, so as to avoid any possible countersinking errors. No templates are required for setting the multiple punch, which is entirely done from the typical rivet spacing drawing.

In staggered riveting, the minimum longitudinal spacing between the rivets of one row and those of the other is 1 inch, but 1⅛ inches is preferable. This space is required for the stops and pawls, which stop the table during the downward stroke of the punch-head. It is, of course, possible to reduce the minimum space to small fractions, but then the human element of error is introduced, as a man has to insert a liner between stop and pawl, equal in thickness to the change in spacing wanted. Otherwise the machine is electrically controlled, except the throwing in of the clutch for punching.

A "pole," being a batten about 3 inches wide by ½ inch thick and of such length as is required, is used as template for the longitudinal spacing. Steel stops are inserted in the holes of the batten corresponding with rivet spacing, or, on the newest machines, steel stops are set up in a steel rack to suit the pole. Different color of light is shown where butts, edge-seams, frames, etc., occur, and the man on the levers is acting solely according to these colors.

The multiple punches have, as a rule, only three or four set-ups; that is to say, one set-up for butts, one for edge-laps, one for frames, one for, say, intercostal angles in conjunction with the edge-laps. In this case the watertight bulkheads could not be punched if the holes would not entirely coincide with one of the four set-ups. It is possible to omit a few holes in some of the set-ups, but this is done only by hand. The man on the punch can release any number of punches temporarily by disconnecting the gag-operating gear for these punch dies.

The Chester Shipbuilding Company, Ltd., has, wherever possible, carried out the idea of duplication and standardization, but very often has had to abandon it in the detail. The hull, engines, boilers, and, in fact, all large items for a group of ships, have been duplicated.

The dimensions for all but two ships contracted for by the Chester Shipbuilding Company are: Length, 401 feet; molded breadth, 54 feet; molded depth, 32 feet 9 inches. Some have had sheer, but, in the latest type, sheer is dispensed with and a raking forecastle and poop substituted, giving the effect of sheer, but simplifying the work of manufacture.

The results of the fabrication in the Bridge Company's mills as outlined above is beyond criticism. Work is fair, rivet holes require no reaming, and the resulting fit of joints and watertightness is excellent. Constructing a ship becomes to a great extent a problem of routing, handling and erection of material and of riveting.

The Chester Shipbuilding Company, Ltd., and the Merchant Shipbuilding Corporation are now building some sixty-eight ships on the manufacturing principles outlined above. It is expected to embody even more than has been possible in the past the manufacturing idea, thus making it possible, in this day of labor shortage, to do a maximum of work with a minimum of skilled shipyard labor of the conventional kind.

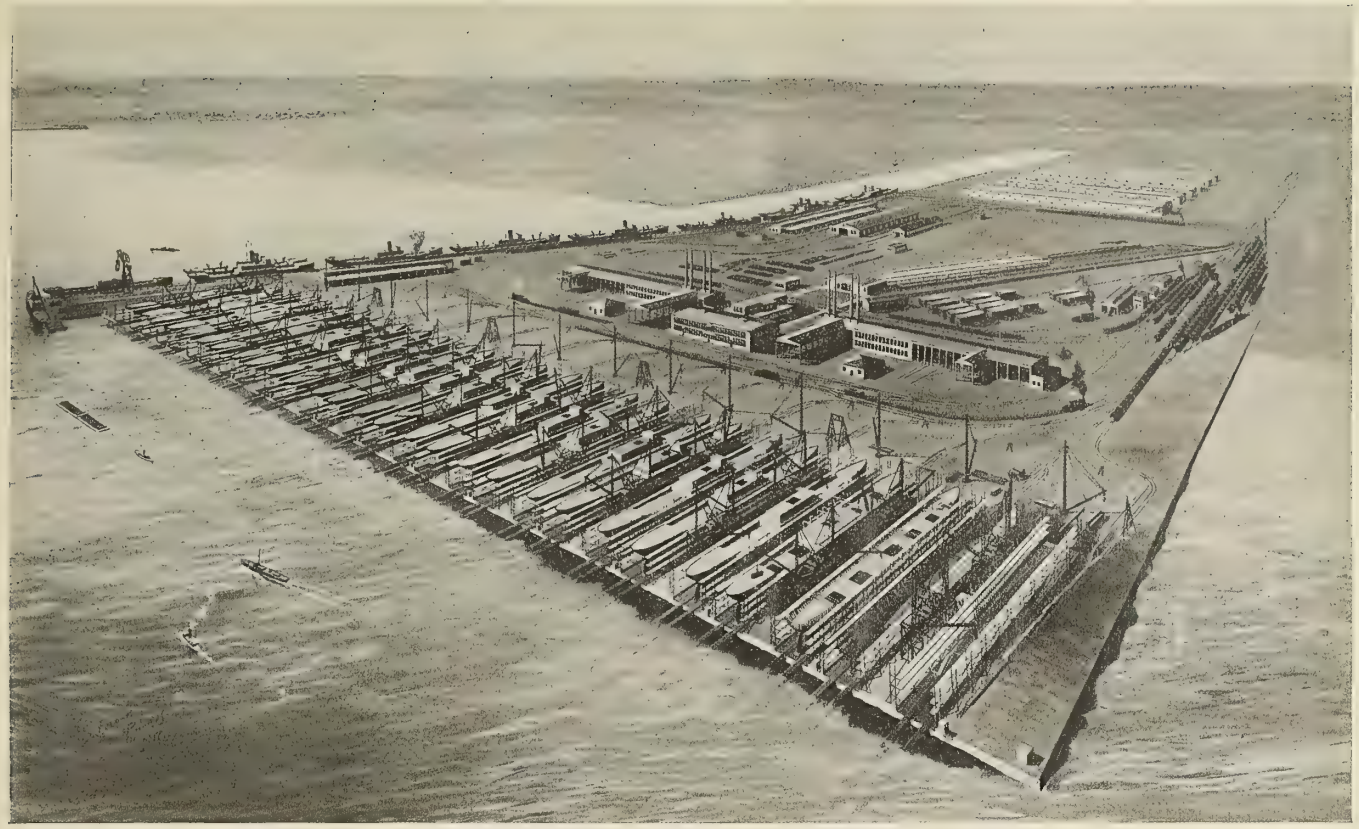
The Men Who Will Build the Ships

(*Concluded from page* 529.)

The Department has also been in touch with numbers of employers and with many large labor organizations, especially such organizations as are directly affected in shipyard work, and has the pledged support of both. The labor organizations have very loyally conducted an examination into the number of workers whom they can find to assist in the shipbuilding programme. These number many thousands and will be produced as the need for their services is found.

There are about eight thousand American towns and smaller cities above village size not large enough to support a labor exchange alone, yet each able probably to supply a half dozen or more skilled workers qualified for shipbuilding. The Service will shortly send a force of skilled traveling agents to comb these communities, find and ascertain the respective qualifications of these workers and distribute them to the yards. The Public Service Reserve will be used to locate them and to avoid crippling local industries in getting them. The Department has compiled a list of 62 cities, none having less than 30,000 population, in different parts of the United States, which have now no public employment office. As the employment office is to employer and worker exactly what the bank is to the investor and borrower, it seems strange that any city of size should be without such an employment office. In the present state of affairs such a condition can no longer exist. England has found its 2,100 employment offices indispensable. We must increase our now feebly supported system; it cannot be too rapidly, if expanded with due regard to the underlying principles of the service. These principles are (1) a recognition of the necessity of efficiently examining workers who are looking for employment, (2) being absolutely impartial and fair, both to worker and employer, (3) never using the service to send workers to an establishment in which a strike exists or is impending, and (4) never to charge a fee.

While in some parts of the country there is a very great shortage of labor, this shortage is more of competency than of actual workers themselves. The Department of Labor is confident that, while it may not always be possible immediately to produce the number of men called for, all that are needed will be found in time to carry out the programme of the Shipping Board. Two or three problems yet remain to be solved. The uneven shipyard wage scales should be scientifically considered and so adjusted that as nearly as possible a common rate shall be fixed, and assented to by all parties concerned, in the ultimate interest both of employer and worker, with due consideration to the rising cost of living. Another important element is the transportation of workers from the interior to the shipyards. Many skilled workers cannot afford to pay their own transportation; there is a question whether they should be expected to do so. If these two problems are solved promptly the Department of Labor has not the slightest doubt that it will be able not merely to supply the needs of the yards, but to build up the permanent force to a point that will enable building of the ships, so far as the supply of labor can contribute toward it, ahead of the present schedules.



Sketch Showing Birdseye View of Government Fabricated Steel Shipbuilding Plant on Newark Bay

New Government Shipyard on Newark Bay

Plant for Building Fabricated Steel Cargo Ships Planned and Erected by Submarine Boat Corporation

WORK began on the new government plant for building fabricated steel cargo ships on Newark Bay on September 20. The Submarine Boat Corporation, of New York, whose vice-president, H. R. Sutphen, was one of the originators of the fabricated shipbuilding idea, is acting as agent for the Emergency Fleet Corporation both in constructing the yard and in building the vessels. The company now has contracts for fifty cargo boats, each of 5,000 tons deadweight capacity, which will be increased to two hundred ships in the near future.

Thirty different structural steel shops are fabricating the steel for the first fifty vessels, and some of the material for the first vessel has already reached the yard. The first keels will be laid in December, and the first vessels launched in March and completed in May. Each ship requires 1,700 tons of plates and shapes, making a total of 85,000 tons of fabricated steel for the fifty ships now under contract.

Fifteen hundred men are at work on the construction of the plant, and as soon as construction of the vessels begins about 12,000 men will be employed.

Layout of the Yard

The yard occupies an area of 125 acres, and in it will be 15 miles of standard gage railroad track connecting the shops, slips and building ways. These tracks are directly connected with the Pennsylvania and Lehigh railroads and the Central Railroad of New Jersey, so that the fabricated material will be delivered direct to the heads of the shipbuilding ways.

Twenty-eight building ways are being constructed, and although the vessels now on order will be of only 5,000 tons the building ways are being made of sufficient width and strength so that they can be extended later on, if necessary, to accommodate vessels of 9,000 or 10,000 tons deadweight carrying capacity. The building ways are served by fixed leg cranes between the ways and large derricks at the head of the ways. Ample space is reserved at the head of the ways for receiving the fabricated material which will go into the ships.

Back of the storage space at the head of the ways in the center of the property is a two-story main administration building, and on either side of this the ship sheds and fabricating shops. The plant is thus divided into two separate yards, to be known as the north yard and the south yard, each with its fabricating shop, 360 feet long. The buildings are of steel with walls of corrugated iron and glass. On the second story of the main shops is the mold loft.

The Shops

Besides the main administration building and fabricating shops, the buildings now being erected include a restaurant, a terminal building, a hospital, storehouses, paint shops, a main sub-station, transformer station and meter house. All of the machinery will be driven by electricity obtained from the Public Service power plants.

On one side of the property is a slip 700 feet wide, with a depth of water of 20 feet, and a complete wharf 50 feet wide and over 5,000 feet long, which will be used as a fitting out berth. Material will be handled throughout the yard by twenty locomotive cranes of from 15 to 25 tons capacity, with booms 30 feet to 75 feet long.

Naval Architects' Annual Meeting

Twenty-fifth General Meeting of the Society of Naval Architects and Marine Engineers—Abstracts of Papers Presented

THE twenty-fifth general meeting of the Society of Naval Architects and Marine Engineers was opened in the United Engineering Societies Building, 29 West Thirty-ninth street, New York, on Thursday morning, November 15, with Lieutenant-Commander Stevenson Taylor, U. S. N., president of the society, in the chair. The first business taken up was the reading and approval of the annual report of the secretary-treasurer, which was read by Assistant Naval Constructor A. W. Carmichael, U. S. N., acting secretary.

The report showed the membership of the society on November 1, 1917, to be 875, as against 797 a year ago. Seventy-eight new members were unanimously elected, and other applications for membership presented during the meeting have brought the total membership up to nearly 1,000. According to the treasurer's report, the total resources of the society amount to $32,744.80, and the total liabilities $265, making the society's present worth on October 31, 1917, $32,479.87.

The following deaths were recorded during the year: Members, W. I. Babcock, Charles E. Hyde, George E. Weed; associates, William Conant Church, John R. Raymond, John S. Hyde; junior, Prentiss Lingan.

The following officers were elected for the terms specified:

Vice-presidents (for term expiring 1920).—Dr. W. F. Durand, Rear Admiral W. L. Capps, U. S. N., Rear Admiral D. W. Taylor, U. S. N., Homer L. Ferguson.

Vice-president (for term expiring 1918).—Prof. C. H. Peabody vice G. E. Weed, deceased.

Members of Council (for term expiring 1920).—D. H. Cox, J. W. Powell, W. A. Dobson, Prof. H. C. Sadler, F. L. DuBosque, A. C. Pessano.

Associate Members of Council (for term expiring 1920).—H. L. Aldrich, H. H. Raymond.

Associate Member of Council (for term expiring 1918).—E. M. Bull vice J. S. Hyde, deceased.

Executive Committee (for term expiring 1918).—Lieutenant-Commander Stevenson Taylor, U. S. N., *ex officio;* Rear Admiral W. L. Capps, U. S. N.; Andrew Fletcher, W. M. McFarland, F. L. DuBosque, J. W. Powell, D. H. Cox, *ex officio.*

The president of the society then read his annual address, from which the following extracts are taken.

Abstract of President Taylor's Address

Taken from last year's address, we find the total capacity per annum prior to 1916, of shipyards for building merchant vessels, to have been as follows:

	Registered Tonnage
United Kingdom, Colonies and Canada	1,984,000
United States, including the Great Lakes	540,000
Germany and Austria-Hungary	527,000
All other countries	634,000
Total capacity per annum of the shipyards of the world	3,685,000

Notwithstanding the decrease in merchant shipbuilding in the United Kingdom and Germany caused by the necessities of war, owing to the increase in capacity of United States yards (about 100,000 tons) and elsewhere in the world (about 76,000 tons) the total production of merchant vessels in the shipyards of the world during this year 1917 will be approximately 3,250,000 tons; almost as much as during the banner year of 1913, when there was launched about 3,300,000 registered tons.

But there has been in this country a great change during this same year. In November, 1916, there were about 66 shipyards in the United States, in 27 of which were built wood ships. At this time, November, 1917, there are about 142 shipyards in the United States, 59 of which are building wood vessels, and 4 of which are building composite vessels. With the tremendous programme of the United States Shipping Board, to which must be added the 787 new ships for our navy at a cost of $1,150,400,000 (£236,000,000), from dreadnoughts to submarine chasers—"making the navy the most powerful in the world, second to none," and the necessary additions to our shipyards to accomplish these feats, you may be sure there will be no idle days, but many busy days and nights for several years to come.

It is to be noted that the increase in the number of new wood shipyards is great, but the capacity of same is not nearly so great as the total capacity of the new steel shipyards. Whether, after the completion of the many wood vessels now under contract for delivery in the next two years, there will be any demand for wood ships from these new yards is extremely doubtful, because in normal times there is no question concerning the superiority of the steel ships.

The amount of destruction of vessels by German submarines is uncertain. British authorities give the net loss of British vessels over 1,600 tons, from the commencement of the war to October 31, this year, as 2,500,000 registered tons. Other authorities say that neutral nations, including the United States, have lost about 1,700,000 tons, making a total of 4,200,000 tons, which is probably too low; certainly much lower than claimed by the German government.

It is clear however, that the special efforts of the naval vessels of the Allies have succeeded in keeping within control the destruction by submarines. British authority also states that between 40 and 50 percent of the German submarines operating since the war commenced have been destroyed; but there is apparently no certain knowledge of the number of German submarines under construction.

The announced programme of the United States Shipping Board for a merchant marine at the end of the year 1919 shows a grand total of 14,500,000 deadweight tons capacity, approximately 9,600,000 registered tonnage. This includes all new construction for their Emergency Fleet Corporation; all alien and United States ships under construction and commandeered and the enemy ships that have been seized within our ports.

To bring to a successful conclusion this programme and the successful operation of same as well is a prodigious task requiring all of the energy, enterprise, foresight and earnest activity for which American leaders are noted. That the Board may be assisted in its desired accomplishment, the whole-hearted support of the members of this Society, a unit of men upon whom so much depends, must be given without limit of service or reserve of any sort.

At the close of the president's address the reading and discussion of papers was begun, the first paper being read by the acting secretary on account of the absence of the author.

The Service Department of a Shipyard

BY SAMUEL W. WAKEMAN

Abstract

The author describes the functions of the Service Department of the Fore River Shipbuilding Corporation, established as a result of an investigation made about two years ago at a number of the leading manufacturing concerns in the United States by a committee of workmen, foremen and others from the yard. In accordance with the recommendations of this committee, a brick building was erected near the main gates of the plant to take care of the hospital work, the employment department and general activities relating to the physical, mental and social condition of the employees.

The scope of the activities of the service department resolve themselves into the following: Employment, hospital, safety work, educational work, apprentices, employees' club, workers' paper, suggestion committee, work yard restaurant and shop training. The *personnel* of the service department consists of the following: Supervisor, assistant, clerks, stenographer, supervisor of instructors, instructors, employment agent, employment clerk, doorman, doctors, nurses and messenger boys for conducting applicants to the shops.

Daily reports are prepared by the employment department showing the number of men hired and leaving by trades; also the daily gain or loss in the working force. Monthly reports are also made of the turn-over of labor, including the number of men hired and leaving by trades, and showing the length of service and reasons for the man leaving. Before this plan was in operation, in order to maintain a force of about 4,000 employees, it was found necessary to hire in the course of a year 8,000 men. During the last six months the present force has been increased from 4,000 to 8,000, and this has been done by hiring only 9,000 men.

It is not claimed that any new or radical ideas have been adopted in connection with the handling of this situation, but what has been done is to find out what successful concerns in other lines of work have done, and to combine them together in such a way that they might be adapted to the work of a shipyard.

Discussion

Naval Constructor T. G. Roberts, U. S. N., pointed out that industrial betterment (or industrial service), formerly known as welfare work, is now being extended to all shipyards through the Shipping Board by Myer Bloomfield, head of the Industrial Service Department of the Emergency Fleet Corporation. One of the most important questions facing a service department is the source of labor. At the Fore River shipyard the service department was placed in touch with a great number of sources of labor through Federal, municipal and various employment agencies very successfully. Naval Constructor Roberts pointed out, however, that the human element is the largest element in management, much depending upon the enthusiasm, happiness and welfare of the workmen.

Rear Admiral R. M. Watt, U. S. N., emphasized the necessity and value of arousing enthusiasm among the employees, and commented favorably on the pamphlets described in the paper which are used at the Fore River yard to acquaint new employees with the details of the plant and its organization. He also called attention to the value of the policy described on page 5 of the paper, whereby foremen of departments recommend discharged men for service in other departments where they may be better adapted to the work.

Shipbuilding in the Gulf States and the Natural Resources and Facilities Favorable Thereto

BY CHARLES N. CROWELL

Abstract

The yellow pine timber supply of the South is furnished principally from the States of Mississippi, Louisiana and Texas. This supply, close at hand to the builder in the Gulf States, gives the advantage of quick delivery and low freight rates, which makes the South and Gulf States especially well adapted for wood shipbuilding.

The facilities for building steel ships are also available. In East Texas, in the region adjacent to Beaumont, there are very extensive areas of iron ore. Plans are already being formed to develop this ore and will probably be put in shape in the near future. Smelters and rolling mills and fabricating plants will be established, and steel ships will be a product of the South. As it is now, several contractors are considering the importation of fabricated steel with which to build steel and composite ships. This supply would come from Birmingham, Memphis and St. Louis. The important factor, fuel oil, is found all through Texas and Louisiana.

Shipbuilding plants have sprung up all over the South; many there are which six months ago were covered with forest growth. Many of these plants to-day are well equipped, containing all modern labor-saving machinery and, in the district lying west of the Mississippi River, at least 150 vessels are building and contracted for. Some of the men who are operating the various new shipyards have never built vessels, but, what is more important, they are men of executive ability, who know how to make up an efficient organization.

The South not only has the material supply, but she has it close at hand; already many building plants are well established and there are available sites for many more. Any kind of a ship and any integral part of a ship may be produced in this southern country. In these days of improved woodworking machinery the skill of the shipwright, once the autocrat of his trade, is largely supplemented and compressed air now does most of the work of fastening, which forms a large percentage of shipyard work. Another advantage of this southern country is the small percentage of time lost, due to the favorable climate in both winter and summer.

Progress of Marine Engineering and the Education of the Marine Engineer

BY ROBERT HAIG

Abstract

The dominating thought in presenting this paper is the hope that this influential body and other kindred societies will impress upon the proper governmental department the urgent demand in this country to-day for trained marine engineers.

In no other country is there such an abundance of well-educated material to draw from to produce highly trained marine engineers, and in none of the other maritime nations is there such an absence of effort on the part of the State to provide the means to train and develop men

engaged in marine engine shops to fit them to take charge of important machinery on ships.

The responsibilities of the seagoing engineer differ widely from those of the land engineer, as the former, once he has left port, is entirely dependent upon his own resources; he and his staff must possess the capacity, unaided, to carry on their duties in face of all difficulties until they can reach another port.

In view of these facts, it is imperative that engineers should be given such experience and training that they can with confidence and ability meet any and all conditions that may arise.

When we consider that the estimated increase in American merchant tonnage in the next three years will be upwards of ten million tons, equal to 1,000 ships of 10,000 tons deadweight, calling for about 5,000 extra marine engineers, we get some idea of the demand that is bound to arise for trained enginers, and the necessity will be imperative that these men should have experienced training, as many of these vessels will have watertube boilers, geared turbines, electric power, refrigeration, etc. All these things will demand experienced care and attention, and without the necessary care and attention we will have vexatious delays and enormously increased cost of operation, and, what is of paramount importance to the nation, we will have a very much lowered transportation efficiency.

The resourcefulness of the engineer at sea is something we are proud of, but day by day his responsibilities are becoming greater, and he should be given the greater opportunity by special facilities of physical and educational training, provided by the Federal Government, to rise in his profession and widen his sphere of usefulness.

The Effect of Wind and Fouling Resistances on the U. S. S. Neptune

BY W. W. SMITH

ABSTRACT

This paper gives the results of a number of observations and experiments to determine the effect of wind and fouling on the resistance of the U. S. S. *Neptune*. During several trials and voyages observations were made in light and heavy winds, other conditions remaining the same, and the effect of the wind determined therefrom. The results obtained are given in the tables, in which the comparisons are based on both speed of vessel and revolutions per minute. Similar data are given for the battleship *New York* and the destroyer *McDougal*, from which it is seen that the effect of wind on the *Neptune* is very much larger than on vessels of ordinary design.

Experiments were also made on the *Neptune's* model in the wind tunnel at the Washington Navy Yard to determine the resistance of the vessel. The resistance as found by the model experiment was about half of that determined by observation. A small part of the difference may be due to errors in estimating the wind velocity, but still there would remain a considerable difference unaccounted for. Even with the experimental values, the *Neptune's* wind resistance would still be very large in comparison with ordinary vessels.

The action of wind on flat surfaces is treated theoretically and formulæ are derived for determining the wind resistance and power of vessels from observations as given in the paper. Diagrams for the relative wind velocities and forces in the several directions required and for all conditions are given in convenient form for reference.

The effect of wind and fouling resistances on the results of standardization and sea trials is discussed and the large possible variation from the standard or designed resistance due to unfavorable conditions of wind and fouling is pointed out, together with the undesirability of departing materially from the standard in both respects.

THURSDAY AFTERNOON SESSION

Recent Development in Tank Steamer Construction

BY ROBERT W. MORRELL, M. E.

ABSTRACT

The author shows that during the recent period of activity in shipbuilding in the United States the number of tank ships has increased 112 percent, the gross tonnage 185 percent and the total deadweight tonnage 185 percent. The total number of American tankers now in service is about 170, having a total gross tonnage of 823,200 and a total deadweight carrying capacity of 1,180,000 tons, which is close to 20 percent of the total steel American tonnage, exclusive of the Lakes, as against 10 percent at the beginning of 1915. In addition, there are now under construction in the United States a total of 64 tank vessels, representing 496,680 gross tons and 575,750 tons deadweight, marking the greatest shipbuilding activity in the history of the country.

The most impressive feature of the modern tanker is the size, the average deadweight previous to 1915 being 5,200 tons, while at present it is 9,100 tons. Along with the increased size has come the development of the shelter deck type of vessel, and more recently the carrying of the expansion trunks right up to the shelter deck, the advantages of which are numerous in spite of the fact that additional steel is required and the scantlings must be increased on account of the increased head of oil. The shelter deck vessel permits carrying an increased deadweight on a limited draft without adopting extreme proportions, as well as giving greater strength structurally.

The growing tendency is also noted of adopting a straight sheer line amidships. As far as the construction of tankers is concerned, two features are of special importance; one, the adoption of the rolled tee-bar section for oil-tight work, and the use of the multiple punch.

In view of the large number of tankers recently sunk by submarines, the author discusses the question of ballasting in order to give the most favorable conditions if the vessel is torpedoed. After carefully considering the subject, the writer's conclusions are:

First.—That no slack tanks should be carried, thereby eliminating the danger from listing.

Second.—That the vessel be given as much reserve buoyancy as possible, which may be the means of saving the ship if torpedoed in the machinery space. Therefore, as little ballast should be carried as weather conditions will permit, but whatever is carried should be in full tanks so distributed as to equalize the loading to the best advantage.

Third.—That gate valves be fitted in the centerline bulkhead near the bottom of each tank operated from the deck, but left open at sea; thus, if empty tanks are pierced, the water will equalize and prevent listing.

Considering the subject of standardizing tankers, the author notes that the sixty-four tank vessels now under construction in American yards represent nineteen distinct types or designs and are being built in sixteen different shipyards for sixteen different owners. The nineteen types range in size from 5,000 to 15,000 tons deadweight and represent almost every possible variation in design. As these vessels were designed by competent men to meet specific requirements and as special vessels are required for special trades in order to obtain the best results it is obviously impossible to design a single vessel to meet

all requirements, and, if an attempt at a compromise is made, it will place practically every oil company at a disadvantage in having to operate vessels which are not quite suitable. The nearest approach to efficient standardization, the author concludes, would be in the adoption of at least four standard designs consisting of two vessels—a large one and a small one—for the sole purpose of carrying cargoes of heavy oil, and two vessels—a large one and a small one—especially for carrying mixed cargoes of light oil.

At the present time the United States Shipping Board has made no provision for tankers in its shipbuilding programme, and, as all of the vessels now under construction are for 1917 or 1918 delivery, when these vessels are completed the building of tank ships will, according to present indications, be at a standstill in this country. That the Shipping Board has made a grave mistake in entirely ignoring one of the most important of the Allies' necessities and one of our own principal industries, by excluding tankers from its programme is only too evident because the demand for tank steamer tonnage is greater than ever, and new vessels will be needed constantly to meet the ever-growing transportation requirements. Not only is the Shipping Board refusing to place new orders for building tank ships, but it will not permit anyone else to do so. This policy can have but one result, and, if immediate steps are not taken, we shall unquestionably be faced by a grave shortage of tank steamer tonnage. This condition is most serious and urgent and demands the earnest consideration of all shipping men having the nation's welfare and the cause in the great struggle which it represents at heart.

Power and Economy Test of the S. S. Pontiac

BY A. GEORGE MATTSSON AND THOMAS DURKIN

ABSTRACT

The paper gives a description and trial data of the S. S. *Pontiac,* built by the Great Lakes Engineering Works, Detroit, Mich. The vessel is a bulk freighter 600 feet overall, 580 feet keel, 60 feet beam and 32 feet deep, constructed on the arched girder and transverse frame system with straight hopper sides 6 feet deep from the skin of the ship extending up to the main deck stringer. She is a duplicate of a dozen or more ships built on the Lakes during the past two seasons, and is considered the most practical, as well as the most profitable, carrier in the iron ore trade now on the Great Lakes.

The ship is of the single-deck type, having a main deck at the end only with her cargo space free from any obstruction whatsoever. Propulsion is by a triple-expansion engine placed aft, with cylinders 24½ inches, 40 inches and 65 inches diameter by 42 inches stroke, supplied with steam by three single-ended, two-furnace Scotch boilers working under the improved Great Lakes Engineering Works' system of heated positive draft and having a total of 6,405 square feet heating surface and 137¼ square feet grate area.

The trial run covered a distance of 225 statute miles on Lake Huron at full speed with full cargo. A speed of 10.875 knots was obtained with an indicated horsepower of 2,441. The coal consumed per indicated horsepower per hour was 1.34 pounds.

Devices for Comparing the Rotation of Shafts

BY DR. K. SUYEHIRO

ABSTRACT

This paper describes an apparatus designed to show comparative speeds and also the relative phases of two shafts which are to be connected together while running by a clutch or other means. The construction of the apparatus involves the principle of a rotating cinematograph. The apparatus was devised by Mr. Tsuchiya, of the Kawasaki Shipyard, Japan, and the author conjointly and has been used in many cases, giving satisfactory results.

FRIDAY MORNING SESSION

Cargo Ship Lines of Simple Form

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

This paper will be published in full in the January issue.

DISCUSSION

Prof. H. C. Sadler outlined experiments made at the University of Michigan in which further simplification of the straight line model was accomplished by doing away with the round bilge, tests being made with models whose sections consisted of straight lines with sharp corners, and also similar sections with the corners cut off by straight lines. Models of this form showed less resistance than the conventional ship models. No difference was found between the ship-shape form and those with the straight-lined sections with the corners cut off except above speeds ordinary in such vessels. The only difference detected between the sharp corner model and those with the corners cut off on a straight line was about 2 to 5 percent up to high speeds. Professor Sadler held that securing the proper slope of the flat bilges is the main question. The sea-going qualities of such a type of vessel have proved satisfactory and the structural features allow simplification in construction. Contracts have been given by the United States Shipping Board for vessels of this type, and the designs have been approved by the American Bureau of Shipping and Lloyd's Register of Shipping.

Naval Constructor McEntee held the opinion that the U-sections forward, as shown in his paper, give better sea-going qualities than the fine forefoot of the models described by Professor Sadler.

Application of Electricity to Various Auxiliaries on Shipboard

BY H. L. HIBBARD

ABSTRACT

In the use of electricity the American Navy has not only been far in advance of the merchant marine, but has led all navies of the world. Europe, however, seems to have led this country in the trial of electrical apparatus for auxiliaries on merchant vessels.

Among the most striking examples of the use of electricity on merchant vessels are the boats being constructed and projected by the Pennsylvania Shipbuilding Company at Gloucester City, N. J. This company has under construction six tank steamers of about 7,500 tons displacement, one of which is nearly completed and another will take the water shortly, which will be propelled by geared steam turbines and their auxiliaries operated by electricity throughout.

In addition to the above tankers, two cargo vessels of 12,000 tons displacement will soon be laid down and which will have an equipment of auxiliary motors similar to the above tank vessels with the exception of the deck winches, which will consist of three of 25 horsepower and eight of 15 horsepower. It is further contemplated that these two cargo vessels will be electrically propelled and operated by two turbo generating sets, each set furnishing current to a 1,500-horsepower motor, the two motors being geared to the single propeller shaft.

In addition to these vessels, this company contemplates the construction also of six cargo boats propelled by geared steam turbines and with electrical auxiliaries similar to the above.

For the above vessels open-type alternating-current motors will be provided throughout and watertight enclosing cases furnished for the deck motors, with the particular view to protecting them from exposure to moisture; but the cases can be removed, if desired, when the vessels are in port, to give the motors ample ventilation.

In contrast to the alternating current used on the above vessels, the Texas Oil Company is soon to construct a tank vessel of approximately 6,000 tons displacement, propelled by fuel oil engines and provided with direct-current, 230-volt motors on its auxiliaries.

While it is not here the intention to discuss in detail the relative merits of various kinds of motors, it may be mentioned that in comparing the direct-current with the alternating-current equipments mentioned above, a saving in wiring, flexibility of speed control, and improved speed and torque characteristic for the deck auxiliaries are on the side of the direct-current equipments. The alternating-current motor, as pointed out above, has the advantage of freedom from moving contacts and the reduction, in consequence, to a minimum of the possibility of sparks in places where inflammable gases might be encountered, as in the case of the tank steamers. This, however, applies particularly to the constant speed, squirrel-cage type of alternating-current motors, the slip-ring type of motor, which is required for some applications being provided with moving contacts.

In connection with the electric propulsion of ships it is interesting to note that, in addition to the very considerable number of electrically propelled ships now being constructed for the navy, this mode of propulsion is receiving considerable attention in its application to merchant vessels. In addition to the two cargo vessels at the Pennsylvania Shipbuilding Company's plant, which it is expected to propel electrically, we are familiar with electrical installations on four oil barges under construction at New Orleans by the Petroleum Transport Company. These boats are twin screw, each propeller being driven by a 300-horsepower, 480-volt, 3-phase, 60-cycle motor, the two motors being operated by one turbo generating set of similar voltage and frequency.

We have thus seen some of the progress which has been made in this application of power in the merchant field, and we feel certain that its application by this time would have been considerably more extended had not the war conditions necessitated, at least in the opinion of the Government officials, foregoing consideration of electrical apparatus in favor of steam in order to produce a merchant fleet in the shortest possible time.

In addition to the advantages which have been considered and resulted from electrical installations on naval vessels, numerous specific advantages are apparent in connection with such installations in the merchant marine, including frequently a saving in space and weight in the installation of the auxiliaries themselves, a very much higher efficiency of operation, and consequent saving in total fuel consumption, the elimination of long and objectional lines of steam piping, which on certain classes of cargo vessels are nearly always installed above deck and result in continual steam condensation; also, on certain of the auxiliaries, particularly those requiring varying speed and load conditions, the electric motor offers some distinct advantages over the use of the steam engine.

Submarine Hulls—Comments on Various Types

BY NAVAL CONSTRUCTOR E. S. LAND, U. S. N.

ABSTRACT

In this paper the author analyzes as far as practicable the merits and demerits of the single and double-hull types of submarine, disregarding entirely the intermediate types. The features compared include deck space and freeboard, strength, form as affecting surface speed and seaworthiness, fuel tanks, sea-keeping qualities, armament, buoyancy, safety in case of collision and sumberged resistance.

The disadvantages of the double-hull type are summarized as follows: (a) The hull tanks are weaker than the spindle hull, and it would be dangerous to pump tanks when deeply submerged. (b) A very large metacentric height is necessary in the light condition in order to obtain a safe metacentric height while submerging and when submerged, otherwise the stability approaches zero when trimming down. (c) A large metacentric height will probably give a safe boat whose surface activities in a seaway will resemble those of a destroyer. This may be relieved by bilge keels. (d) In a double-hull type, the benefit of the free ballast water is more profound than in the single-hull type, because in the former the weight and moment of the ballast water are larger than in the latter.

The advantages of the single-hull type are summarized as follows: Simplicity of construction, lighter weight and less time to fill tanks.

If the size of the type is considered, the author points out there will come a dividing line beyond which the double-hull type has many important advantages over the single hull. As regards this point, he says there can be little question but that for boats up to 600 tons surface displacement the advantages of single hull predominate. From 600 tons to 800 tons there is little to choose from, but beyond 700 tons it appears that the double-hull boat has the call, and when greater displacement than 800 tons is considered the advantages of double-hull boats for work with the fleet greatly outweigh the advantages of the single-hull type. There appears to be little to choose from in the two types when it comes to the question of stability. In the single-hull type we find a small surface metacentric height and a considerably larger submerged metacentric height. In double hulls, on the contrary, we find a large surface metacentric height and a comparatively small submerged metacentric height. With more recent types, where displacements are around the 800-ton mark, it is becoming increasingly difficult to equip a single-hull boat with the armament and equipment desired and yet retain the requisite surface stability.

As to the future development in submarines, the author points out that the 1918 programme calls for nothing but the 800-ton type, which is believed to be a great step in advance. Submarines of 2,000, 3,000 and 5,000 tons have been projected in foreign navies, and some of them are actually in existence, but the author ventures the prediction that the great preponderance of submarine construction going on to-day in the great navies of the world is in the vicinity of the 800-ton type, which he believes is the most useful all-the-year-round type of submarine.

FRIDAY AFTERNOON SESSION

At the opening of the afternoon session, Henry A. Magoun, vice-president of the New York Shipbuilding Corporation, presented the following resolution, which was unanimously adopted.

"Having in view the trying period through which our country is going, and the vital necessity of hearty patri-

otic co-operation by every class in the community, and,

"Having in view the intimate relations of employer and employee between the members of this society, therefore

"Be it resolved, That it is the sense of this meeting that the Council be asked to formulate suitable resolutions to the President of the United States assuring him of our loyal support in every way, and especially endorsing his earnest efforts to arouse the patriotic enthusiasm of labor, organized and unorganized, to put forth every effort to insure the victory of our arms."

Fabricated Ships

BY R. H. M. ROBINSON

This paper is published on page 549.

Discussion

Prof. H. C. Sadler, while admitting that it is possible to speed up the manufacture of parts that go into a ship by utilizing manufacturing processes, declared that there remains the question of putting the parts together, and especially the operation of riveting. The problem which must be faced is the delivery of the goods on the other side of the Atlantic. Vessels must not be delayed by faulty riveting or failure of machinery. In other words, we must build superior ships, not vessels hastily put together.

The Influence of the War on Submarine Policy

BY MARLEY F. HAY

Abstract

It is not at all clear that before the war any of the Allied Powers, or for that matter the Central Powers, seriously anticipated or contemplated the possibility of ruthless submarine tactics against merchant shipping as at present employed by Germany. That it was not a predetermined policy before the outbreak of war appears to be evidenced by the fact of Germany's complete unpreparedness at that time to conduct submarine warfare, coupled with the further fact that the design of the earlier German submarines indicated the intention of anti-warship rather than anti-merchantman tactics.

The experience of the war has taught submarine officers to make the most of the virtue of invisibility; showing more than the top of a periscope during the twenty hours of daylight in the summer months is an undue risk not to be taken without sufficient reason. The energy of the battery must be conserved, however, to be available when needed in an emergency. To that end arrangements have been perfected to facilitate what is variously known as balancing, statical diving or suspending. With a minimum expenditure of power, the vessel remains stationary in the submerged condition with only the tops of the fully extended periscopes exposed. With the sensitive listening devices now extant it is of vital importance that this mechanism be as nearly noiseless as possible and that no air bubbles escape to betray the presence of the boat.

During the first years of the war little success was experienced in combating submarines with submarines, principally for the reason that their reciprocal invisibility militated against their finding each other except when one was on the surface. Later developments in submarine signaling and sound-detecting devices have made it possible, however, to hear a submarine even when it cannot be seen, and also to approximate its direction. Proceeding in the direction whence the sound came, an effort would be made to locate the enemy's periscopes and get within torpedo range. Any submarines now in commission provided with the latest listening plates could perform the function of a submarine patrol with a certain degree of success, but it is evident that a submarine designed especially for this kind of work, in short a contra-submarine, would logically depart considerably from the characteristics of submarines proper as we now know them. While it is possible to make a compromise design combining the essential characteristics of the submarine-versus-warship type with the submarine-versus-submarine type, such a compromise is not compatible with the highest requirements of either and is likely to entail the weak points of both and the pre-eminent advantages of neither. For that reason two distinct and separate types are to be preferred.

The contra-submarine will do practically all of her work submerged. Therefore, the displacement should be sufficient to ensure satisfactory habitability, and a very powerful battery and large motor should be installed to give the maximum possible endurance submerged and the highest submerged speed at the maximum discharge rate of the battery. On the other hand, battery efficiency expressed in output per pound of weight is highest when the individual cells are not too large, especially when the vertical measurement is at a minimum; nor is it desirable to unduly increase the voltage. Hence practical limitations are imposed which will possibly determine 500 to 600 tons as a satisfactory surface displacement. Facility of maneuvering submerged also inhibits too great a displacement.

Everything that contributes to resistance submerged should be examined critically with a view to reduction or elimination.

As for armament, torpedoes, say, of 12-inch diameter, would be preferable. As many tubes as possible should be grouped for simultaneous firing, arranged at slightly divergent angles, with torpedoes set for various depths, so that dispersed fire is obtained on the principle of a shotgun.

Discussion

Simon Lake endorsed the statement made by Mr. Holland years ago that it is impossible to fight a submarine with a submarine. He believed, however, that the submarine is the antidote of the submarine, not by hunting it, but by evading it, and favored the building of merchant submarines, exhibiting plans for 5,000-ton and 7,500-ton boats of this type.

Mr. Hay pointed out that the German merchant submarine *Deutschland* was capable of carrying only 20 percent of its displacement and expressed the belief that the large merchant submarine is a hopeless project.

An Analysis of the Principles of Industrial Management

BY NAVAL CONSTRUCTOR T. G. ROBERTS, U. S. NAVY

Abstract

Originally, the purpose of the author was to reach a conclusion as to the wisdom of installing the Taylor system in the navy yards; and the years 1911-1912 were devoted to an investigation of the various phases of the question, the conclusion having been reached in 1913 that many of the claims were justified, but that the Taylor system, as a whole, was not suitable for application throughout a navy yard; and this view was communicated at the time, and it is hoped with some effect, in that connection.

The paper which the author has written, covering over one hundred pages and divided into some eighteen chapters, is an exhaustive treatise of the subject. The first chapter attempts to evaluate the Taylor system in popular style by exposing the underlying principles and showing that it comprised a particular combination of elements, most of which were derived from the best practices de-

veloped in industrial management generally and combined with a few new elements devised by Mr. Taylor. The essence of the Taylor system was the premium and the time study, which he called the "arch" and the "keystone," respectively. The labor organizations aimed straight at the arch and the keystone, and have finally succeeded in causing laws to be passed forbidding the use of those mechanisms in Government work.

The next chapter deals with the question of the tool, and shows how Mr. Taylor built up a system of auxiliary services around the point of the tool, so as to remove the greatest amount of material in the least possible time by a tool operating continuously between clock-strike and clock-strike. The problem resolved itself into determining the proper speed, feed and depth of cut to adopt in order to remove the greatest quantity of material in the shortest time. The next chapter deals with the machine carrying the tool and of perfecting it so that it would drive the tool at the desired speed, feed and depth of cut, while the following chapter deals with the question of the belt, as a veritable little branch of scientific management was necessary in order to tighten, adjust, renew and care for leather belting outside of the regular working hours, so that it would not break or slide off or operate under inefficient tension during working hours. The succeeding chapter deals with the question of the man and the auxiliary services necessary to supply him with tools, jobs, materials, supplies and instructions, so as to keep him operating continuously without loss of time between jobs.

The next chapter describes Mr. Taylor's functional foremanship, the great principle of which has been understood and adopted in modern industry, especially in the great shipyards in the employment of a far greater number of superintendents, foremen, quartermen and leading men than ever before, and these, under some name or other, nowadays perform the same work in substance as that outlined under the functional foreman.

The next chapter illustrates time study and explains its constituent parts, distinguishing between time study and motion study, and pointing out the best example in motion study available—that of the case of bricklaying as developed by Mr. Frank B. Gilbreth.

The next chapter explains the bonus and the premium as synonymous terms, and distinguishes between day work, on the one extreme, and piecework on the other; where in the former case the management reaps all the benefits in case of increased production and the workman, in the case of the latter. The various wage systems that have been invented are set forth and illustrated and fall somewhere between the two extremes of day work and piecework.

The psychology of management is dealt with in the next chapter, showing that efficiency engineers have adopted the correct lines by taking advantage of a man's nervous system as an ally, instead of an enemy. The considerations of the mind and the reactions of the body are fully discussed as affected by motion study, bonus, repeat work, functional performance of work, division of labor and specialization.

From the psychological viewpoint, time study and bonus are in keeping with political economy and great benefits to employees, employer and society at large. A discussion of political economy in management follows, showing the falacy of the policies of organized labor in their fear and hatred of overproduction. Various examples are given showing that specialization, on the whole, has produced greater efficiency and a greater number of products and greater emoluments, comparatively speaking, than in former times, when varied production was the rule.

The succeeding chapter is devoted to Mr. Taylor's work, "On the Art of Cutting Metals," in which is brought out tersely and clearly the various and wonderful developments in the application of modern tool steel.

The next chapter deals with the so-called Emerson system, and shows that it is practically the same as the Taylor system, by the substitution of different names, so far as the machine shop is concerned. Mr. Emerson's system, however, goes beyond the shop and deals with compound management, involving many shops. The author discusses the installation of modern, efficient management in an inefficient plant, and points out the way in which it can be best and quickest done. The Vickers system, from the British shipyard of that name, which the Navy Department said it would introduce in some of the navy yards a few years ago, is taken up next. It is shown that the essence of the Vickers system consisted of the time study and the bonus, and that these can be traced back to Mr. Taylor at the Bethlehem Works. The following chapter deals with various other considerations affecting shop management in general, including the committee, or board, system of Mr. Charles U. Carpenter as practiced in establishments in general, and in one great shipyard in particular. This is followed by a chapter dealing with organization, and a chapter devoted to cost accounting, in which that work is held to be the function of the engineer and the supplying and the administration of the vehicle is the function of the cost accountant or bookkeeper, whose operations are subject to be determined by the engineer.

The succeeding chapter deals with welfare work, in which are elaborated a great number of elements which have been introduced in modern industry, while the final chapter is devoted to the shipyard of to-day, contrasting the shipyard of disorder and dirt of the past with the improved yard of the present. The example of the Fore River shipyard is cited in particular, and others in general. The detailed workings of the "safety first" movement, the committee system and the welfare movement are shown, as applied to shipyards. The application of the various wage systems has been set forth. A practical machine rate system of accounting is exhibited for a machine shop, and the question of cost and overhead charges is exhibited in connection with the policy when in past years "depreciation" has been neglected as an element of cost—but not so now, under the "cost plus" contracts for the Government, where the shipyards have not remained behind the times.

In conclusion, the author points out that while the shipyards have improved greatly in recent years, nevertheless shipbuilders will, no doubt, be willing to admit that there is still room for much improvement.

Gyro-Ship Stabilizers in Service

BY ELMER A. SPERRY

ABSTRACT

Several interesting and successful installations of gyro stabilizers in commercial, pleasure and naval vessels for the prevention of rolling are illustrated and described in this paper. The stabilizing equipment, considered in the light of the results accomplished, is insignificant in points of size and weight, usually weighing not far from one percent of the displacement even for large ships and costing per pound not far from other mechanical equipment on shipboard. The advantages gained include not only the effective suppression of rolling but in a seaway a dryer ship and for the same number of propeller revolutions the same speed as in still water, together with a reduction of stresses in the hull due to the action of the waves and the unlooked-for advantage that the stabilized ship holds her course remarkably in a heavy sea with little or no helm.

Letters from Marine Engineers

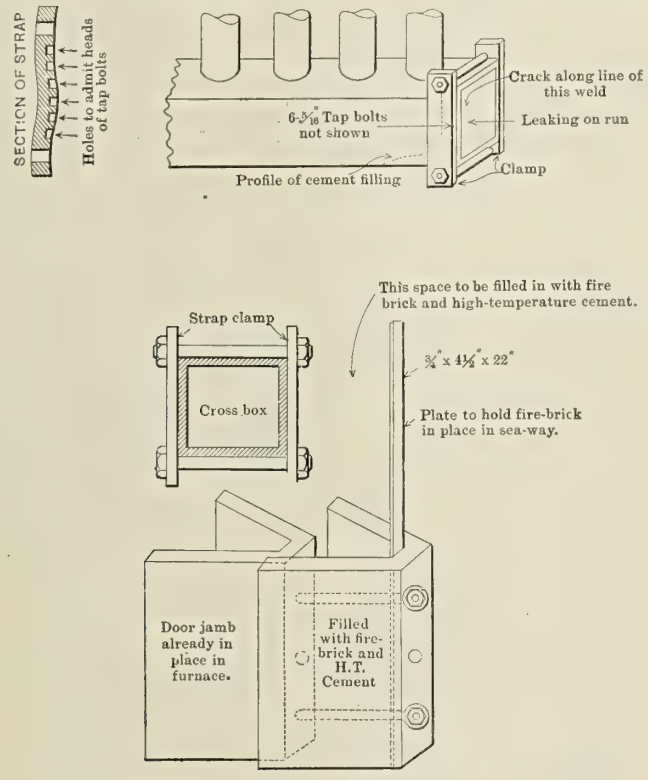
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Repairs to Leaky Cross Box in Babcock & Wilcox Boiler

The following incident regarding repairs to a Babcock & Wilcox marine boiler is submitted in the hope that it may prove of interest:

While under way from ..... to ....,... a distance of 1,800 miles, the main boiler of the ..... (B. & W. marine type) developed a leak in the port cross box at the weld on the inboard end, the defective section of this weld extending a distance of 4 inches, much water and steam coming through the crack. A distance of 1,500



Repair to Defective Cross Box of B. & W. Boiler

miles remaining to complete the run and the vessel having but one boiler, it was necessary to continue the run and make up the extra feed required by the use of the evaporator, weather conditions at the time forbidding making repairs at sea.

Upon arrival at ....., the end of the run, the boiler was blown down and inspected, and it was found that the leak in the port cross box was in a vertical crack in the after side of the inboard end of the box in line with the weld between the metal of the cross box and the ¾-inch plate plug which closes the end of the box.

The repairs made consisted of the following:

Drilled and tapped six 5/16-inch holes through the metal of the cross box and into the plug about ⅝ inch. Red lead was forced into the crack (by means of a red lead gun) and tap bolts screwed hard up in these holes to close the crack. Also made and fitted a double strap clamp of ¾-inch plate about 4 inches wide and of a suitable length, set up with ¾-inch bolts in the manner shown in the sketch. The strap fitted on the after side of the cross box was convexed so as to put the strain over the crack; holes were partially drilled in the bearing surface of the after strap to admit the heads of the six tap bolts, and then filled the end of the box with Portland cement, sloping gradually back a distance of 5 or 6 inches. Care was taken when placing the cement to insure circulation for the nearest nipple and space for its replacement if necessary.

The repairs were protected from the heat of the fire by making use of a guard consisting of a door jamb, fire-brick and high temperature cement, the door jamb guard being secured to the door jamb already in place in the furnace, as shown in the sketch.

After completing the repairs they were tested under 160 pounds hydrostatic pressure (the allowed working steam pressure on the boiler being 110 pounds) and no leaks were visible.

The repairs to the cross box have now held without any leaks for a period of three months, the vessel cruising continually, and the repairs are not affected by the heat of the fire as long as the guard is maintained in efficient condition. The life of the guard is about one month, when it is then necessary to renew same. The renewing of the guard is a simple matter and is done while the boiler is under steam, the fires being hauled temporarily.

It was not possible at the time repairs were being made to obtain the use of a welding outfit. J. F. H.

Condenser Notes—Partial Loss of Vacuum —Leaky Tubes

There are numerous causes for partial loss of vacuum, chief of which are the leaks of air into the system. The low pressure valve and piston rod stuffing boxes of the main engine will be found the most troublesome of all the sources of air leakage. Leaks around these and other packing glands can be detected readily by holding close to them a flame. (A good torch for seeking out leaks is made from a pine stick dipped in alcohol and then lighted.) This will be sucked in, thus showing the leakage of air into the condenser, which will partially destroy the vacuum.

When the vacuum drops suddenly, or to any great amount, all the valves of branch exhaust lines leading to pumps and machinery should be examined, for if they be open when the machinery is not in use it multiplies the number of chances for air getting in. Sometimes a piece of auxiliary machinery is undergoing repairs, the cylinder or valve chest is open, and the machinist has neglected to secure the exhaust valve, or it may be leaky—all such points must be carefully watched when vacuum is poor and troublesome.

When the stuffing boxes and valve lines and joints are O. K., then the valves of the air pumps may be to blame

for low vacuum. These valves should be a free fit, lift easily on the studs, and be of sufficient width to cover the seat opening adequately. They should be light rolled bronze material. Generally three separate disks are used, of varying diameters, to make up one complete valve. (The springs of the bucket and suction valves should be light and durable, having only enough tension to insure seating of the disk.) It must be understood that when stiff springs are used, it will be necessary to have a higher vacuum in the pump cylinder to lift them; this necessitates increased speed of the pump.

The valve disks, springs and studs can be examined to see if they are intact by removing the handhole plates fitted in the pump barrels and discharge chests, ofttimes due to the collection of grease and sediment into small lumps and balls.

Some of these valves will be found to be partially raised off their seats. These, of course, must be cleaned and seated. Worn, twisted or warped valves are also causes for poor vacuum. In replacing the handhole covers, be sure to get them into their original position, for a part of the cylinder wall is formed by their inner surface.

When the air pump and all parts of the system are found to be in good order, there are still a few other traceable causes for defective vacuum. The suction of the air pump may be too warm. Generally, when this trouble is found, it is caused by insufficient supply of circulating water, or fouled tube surfaces, but it may be that the condenser is temporarily overloaded and lacks sufficient cooling surface. This seldom is the cause with large condensers, but is frequently found to be the trouble with the smaller auxiliary ones, when too much machinery is allowed to exhaust into them.

Lack of circulating water may be due to slow speed of the pump, choking of the intake by marine matter, grass, etc., plugging and fouling of the interior of the tubes (small fish, mussels, barnacles, sodium scale, etc.). Most of the trouble with internal tube fouling and choking will be found in the lower half and the end nearest the delivery of the circulating pump. When the ship is lying in shallow draft, river harbors, etc., particular attention must be given to keeping the intake clear. (There is nearly always a steam blowout or cleanout valve at the bottom or neck of the injection valve.) When the strainer over the intake is choked, the circulating pump is slowed down or stopped and the injection valve closed, then the full boiler pressure is slowly admitted below the valve disk, which blows out and sets up a violent agitation of the water in and around the strainer compartment.

The interior fouling and scale can be removed by several methods. The cleaning, if to be complete, calls for the removal of the large heads; this permits accessibility to all tube ends. Small round wire fagot tube cleaning

Fig. 1

brushes, as shown in Fig. 1, are used when the fouling is soft and easily removed; they are pushed through by small round rods.

After the brush has been passed through the tubes, they are washed out by water pressure admitted in a specially designed nozzle (Fig. 2) which takes in two or more tubes. It is made from an ordinary pipe cap, in the base of which are drilled and tapped two ¾-inch pipe holes for two short pieces of ⅜-inch pipe; these are turned down taper to fit the ends of the condenser tubes quickly and easily.

There are several types of mechanical tube cleaners for removing the scale which forms on the inside of the condenser tubes. When this scale is of but minor thickness, and does not seriously cripple the condenser efficiency, it is best left alone, for it has been proven that it has a protective effect against tube corrosion. Most

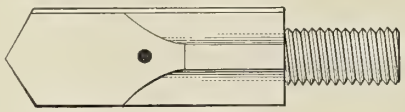


Fig. 2

mechanical power cleaners injure the small tubes. The inside diameter of most marine condenser tubes is ⅝ inch, and many of these will be found somewhat deflected and warped out of alinement. In using mechanically operated cleaners in the small tubes, many are cut and injured.

One type of scale drill is shown in Fig. 3; this is revolved by air or electric motor. Water pressure is used

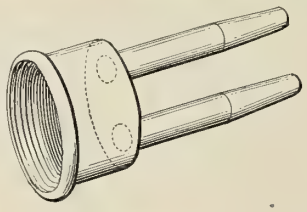


Fig. 3

in connection with its operation, the rod or shaft and the drill being hollow for the purpose. Other methods of internal tube cleaning are that of sand blasting, scraping and shooting. The shooting method consists of making several small plungers of just an easy fit in the tube, and of ½-inch length. These are placed in one end of the tube and shot or forced through by air or water pressure applied to the end of the tube.

In performing any of the above cleaning methods, it must be borne in mind that the cleaning tools are inserted and worked against the direction of the flow of the circulating water.

Perhaps I should mention here that it will be found that the lower half or bank of tubes will need cleaning more often than the upper section for two reasons: First, they will necessarily receive the foreign matter direct from the pump delivery; second, they are near to the suction of the air pumps, and should be in best condition to cool the air and condensate.

External fouling of the tubes is caused by the adherence of oil and grease carried in suspension in the exhaust steam. This, however, is easily removed by the boiling out process, and it is seldom necessary to clean the steam side more than once a year. The grease that adheres to the tubes forms a spongy coating, and into this will be found imbedded grit and fine abrasive dust from the machinery, cylinder walls, etc. The baffle plates and upper tubes will be found to receive the most of the fouling.

To remove the grease, the best method known to the writer is: Fill the shell with fresh water heated to 180 degrees. Dissolve 50 to 75 pounds of boiler compound, or a caustic soda, and pour this in through the top manhole. Then by closing the hot well, or air pump discharge valve, and making a temporary hose connection next to the

pump, the water of the shell can be circulated by discharging from the lead of hose into the manhole on top of the condenser.

A small steam hose can be connected to keep the solution at 180 degrees temperature. In pumping back the solution, a careful man can clean all the upper tubes quickly and easily by directing the force of the hose discharge over all the surface within reach.

Generally three to four hours of circulating mixture will be sufficient to thoroughly clean badly fouled tube surfaces. The temperature should never be allowed to get much higher than 180 degrees, for it will, with the strong caustic solution, have a bad effect on the tube end packings. After completing the boiling out, the solution is drained off, and the shell and tubes thoroughly washed off with fresh, clean water.

In marine practice, a leak of the circulating sea water into the steam space is a serious thing, and steps must be immediately taken to find the leaky tube or packing and remedy it. A small size leak will salt up the feed water in a short time. In addition to the pressure of water delivered from the circulating pump, there is the pull of the vacuum to multiply the volume of any small leak into the steam space. Once in the writer's experience, an attempt was made to clean the inside of the tubes by turning live steam into the shell when the tubes were dry and the heads removed. The plan was to dry the fouling or deposit inside the tubes by baking with the steam, then blow out the dried dirt and sediment by compressed air and follow this up by washing. The plan worked well for cleaning, but resulted in many leaks around the tube ends. The packing dried out, and many of the ferrules were loosened, resulting in severe leakage of the tube sheet.

To find a leak in the steam space, there are several popular methods, but perhaps the one most applicable to all ships is that of putting a vacuum on the shell and going over the tube ends with a large torch, watching for the flame to be sucked into the leaky tube.

When possible, a better method is to fill the condenser shell slowly with water and, while the water is rising, note the ends of the tube for leaks. When the water reaches the top, apply an air pressure of 20 pounds on the surface, pumping the air in through the exhaust line, which must be blanked off. If it is a main engine condenser, and all engine parts are closed (cylinder heads, valve chests, drain valves, etc.) and the rod packings are tight, the air can be pumped into the engine exhaust direct from the compressors without the lines being blanked near the condenser, then the air pressure is built up by filling this extra volume. Leaky tubes can then be found by water spurting from their ends, and these marked for renewal. In the older types the tube ends are packed

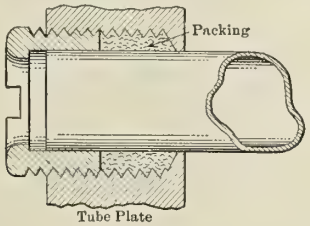


Fig. 4

in the sheet with corset lacing, this being compressed by ferrules, as shown in Fig. 4.

Modern practice calls for the tubes being expanded into one tube sheet, and packed in the other one with gray fiber washers. This still permits the necessary expansion and contraction movement, and reduces the field of leakage to practically one end.

Concord, N. H. C. H. Willey.

Renewing a Yoke Stud

Due to the improper position in which our boiler bottom blow-off valves were installed, one of the studs of the yoke corroded severely, due to the leakage from the stuffing box striking on it. When overhauling the valve and trying to take this stud out, it became broken.

Fig. 1, at *A*, shows the original type of stud. To make one like it required a lathe, and not having any

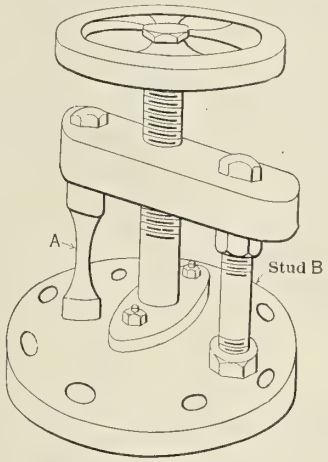


Fig. 1.—Sketch of Yoke

on board, a common ⅞-inch stud was made, as in Fig. 2, and this put in, as shown in Fig. 1 at *B*.

The distance between yoke and bonnet can be adjusted by the two nuts to correspond exactly to the same distance

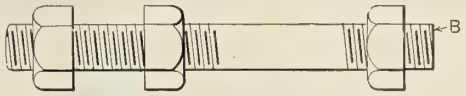


Fig. 2.—Seven-Eighth-Inch Stud

as the shoulder of the solid stud at *A*. This prevents the cocking or tipping of the yoke, which would make the stem bind. Machinist's Mate.

Men for the Emergency Fleet.—One of the graduates of the Shipping Board's free navigation school at San Diego recently passed his examination for second mate before the inspectors at San Pedro with the highest marks ever given in a similar examination at that port. One student in the second class about to be started at San Pedro is a university man, and is leaving an irrigation project job worth $10,000 a year to fit himself as an officer in the merchant service. He has had sea experience.

American Foreign Trade in September.—American exports in September totaled $456,201,567 (£93,500,000), according to a statement just issued by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. This is a decrease of approximately $34,000,000 (£7,000,000) compared with August, but a gain of $80,000,000 (£16,400,000) as compared with July. For the nine months ended with September the total exports were $4,607,817,178 (£945,000,000), a gain of $657,000,000 (£135,000,000) over the similar period in 1916.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Scotch Boiler

Q.† (921).—Sketch a sectional view of a Scotch boiler (single ended), naming each part, and state fully how each part is secured in place.

A. (921).—A sectional view of a single-ended Scotch boiler is shown in Fig. 1.

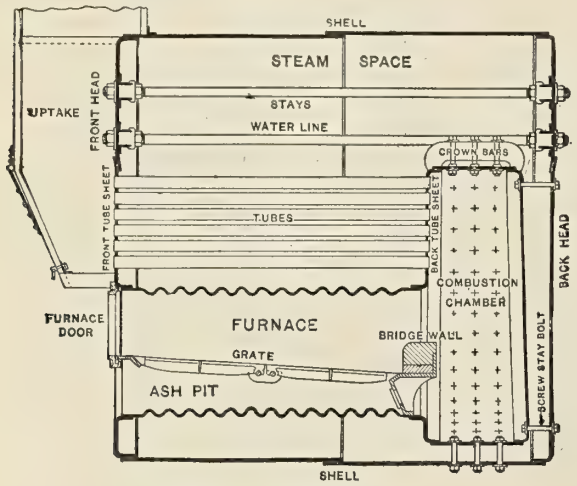


Fig. 1.—Scotch Boiler

Name of Part	Secured to	How Secured
Furnace	Front head	Riveted to flange
	Front of combustion chamber	Riveted to flange
Combuston chamber	Furnace	Flanged and riveted
	Back head	Staybolts
	Bottom	Staybolts
	Tubes	Tubes expanded into it
Tubes	Combustion chamber	Expanded into
	Front head (tube sheet)	Expanded into
Uptake	Front head	Bolted to lugs
	Top	Bolted to lugs
Stays	Front head	Bolted
	Back head	Bolted
Heads	Shell	Flanged and riveted

Evaporator

Q.* (922).—What is an evaporator with one or two sections and how would you take care of evaporator?

A. (922).—An evaporator is a device to produce fresh water from sea water by boiling it and condensing the vapor. If it is used for make-up feed, only the steam from the sea water in the evaporator is led directly to the main condenser, where it is condensed and enters the regular feed system via the hot well. If the evaporator

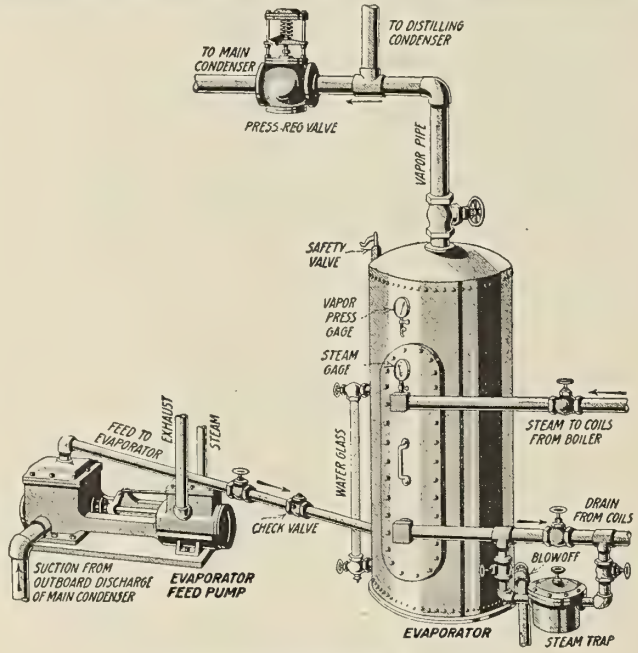


Fig. 2.—Boiler Make-Up Evaporator

is used for the production of drinking or potable water, the steam from the sea water is led to an independent condenser and the condensate thence to special tanks.

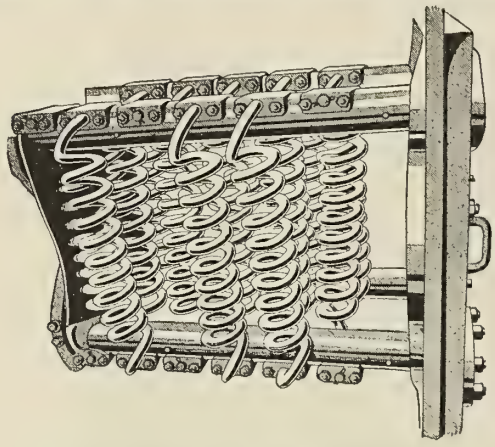


Fig. 3.—Evaporator Coils and Manifold

When used for this latter purpose, it is usually called a "distiller."

A common type of evaporator consists of a shell containing the salt water into which are immersed a number of brass (not copper) coils, through which hot, live steam flows, giving up sufficient heat to boil the water in the shell. A characteristic arrangement of an evaporator is shown in Figs. 2 and 3, illustrations reproduced from *Power*.

In starting an evaporator for the first time, it is desir-

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy Annapolis, Md.

able to apply the full steam pressure that the coils are intended to carry to search out any leaks that may be there. If tight, start the salt water feed pump and fill the shell to about 2 inches in the gage glass. When the salt water boils the level will rise considerably. Adjust the steam valve to the coils to give the desired pressure in the coils and the vapor valve to give the desired shell pressure. These pressures vary in different installations, but should always be enough different so that the difference in the temperature of steam corresponding to each pressure will be not less than 25 degrees F. This is for low capacity operation. The rated capacity is usually based on a temperature difference of 90 degrees, for which the following table gives the

Desirable Steam Pressure for Different Vapor Pressures

Coil Pressure (Gage)	Vapor Pressure (Gage) Atmos.
55	1
58	2
61	3
65	4
68	5
72	6
75	7
78	8
80	9
85	10
87	

Watch the stopcocks on the manifold drain, which should be open to bleed air and vapor continuously.

The level of the water in the gage glass is (when operating nearly full capacity) nearly 12 inches below the actual water level, due to the priming of the salt water, and care should be taken to see that the coils are kept fully submerged. This will be done if the water is kept halfway up the glass.

Blow down frequently to maintain salinity of not over 3/32 and preferably less.

Evaporators should be scaled after 250 to 300 hours' use, as the scale on the coils reduces their heat transferring ability to a marked extent.

Cast iron shells are better for evaporation than steel plate shells.

Salinometer

Q.* (923).—In case you broke a salinometer, how would you make one to serve the purpose?

A. (923).—First obtain a slender bottle, and place a small amount of buckshot in it, and cover the latter with wax or paraffine. Place the prepared bottle in a container of fresh water, and then mark the water level upon the bottle. This will be the zero of the scale to be made. Take a gallon of sea water and proceed as above to determine the 1/32 reading. Then take two gallons of sea water and boil it until one gallon remains. Then, as before, determine the flotation point. In like manner boil three gallons of sea water until one remains, and determine the 3/32 point. (The above procedure only applies when the sea water used is of 1/32 salinity; the waters of the Atlantic and Pacific oceans are very nearly 1/32 saline.) Thus the bottle has graduations for 0, 1/32, 2/32 and 3/32 salinity, and may be used successfully as a salinometer.

Precautions for Marine Engineers

Q. (924).—What precautions and preventions should a marine engineer take? Name nine different places.

A. (924).—"Practical Marine Engineering," by C. W. Dyson, suggests the following as desirable routine orders for the engine room in port: "Be careful to secure pumps, air compressors, etc., when they are no longer needed. Clean engine room bilges each week on day assigned. Allow no one in engine rooms or fire rooms from 9 P. M. to 5 A. M. except men on watch and those on duty. No smoking in engine room hatches. Men will be kept out out of hatches except those detailed there for cleaning stations. Keep all unnecessary lights turned out at night. In general, run evaporators on ship's tanks from 8 A. M. until they are full, then shift below to reserve feed tanks for the night. This will avoid overflowing ship's tanks during the night. Jack, daily, auxiliaries not in use. The oiler on watch should always know who are the officer and chief petty officers on duty. Their names should be entered on the auxiliary watch list or condition blank kept at engine room log desk. In case of any accident or derangement the officer and chief petty officers on duty will be informed."

Separators

Q. (925).—What are separators and where are they used?

A. (925).—Separators are devices, found in great variety, for separating steam and water, and utilize various principles in their operation. Separators are used on steam lines, or, wherever the steam is likely to have any considerable proportion of water.

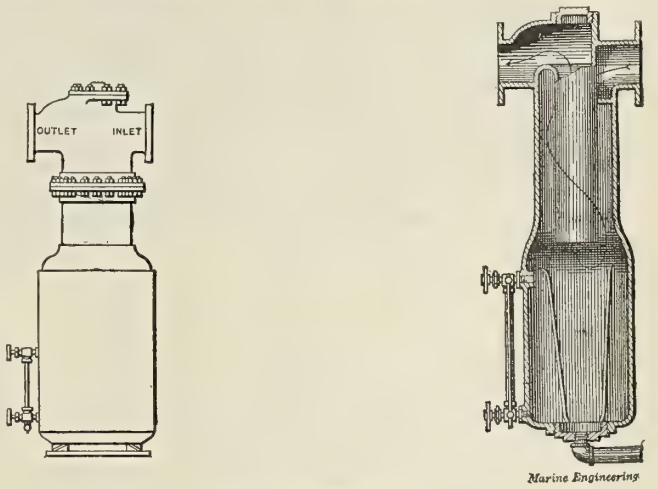


Fig. 4.—Separator

Horsepower Constant

Q. (926).—What is the constant for horsepower and how is it obtained?

A. (926).—Engine constant is a factor determined for each cylinder of the engine from the dimensions of the cylinder. It is the part of the formula for indicated horsepower enclosed in the brackets:

$$I.H.P. = \frac{2PLAN}{33{,}000} = PN\left[\frac{2LA}{33{,}000}\right]$$

P = average mean effective pressure, pounds per square inch,
N = revolutions per minute,
L = stroke in feet,
A = average area of the two sides of the piston, square inches.

$$\text{Engine constant} = \frac{2LA}{33{,}000}$$

Degree at Which Salt Deposits

Q. (928).—At what degree does salt deposit?

A. (928).—Salt deposits at 8/32 to 10/32 (25 to 30 percent).

MAIN BATTERIES OF THE U. S. S. PENNSYLVANIA

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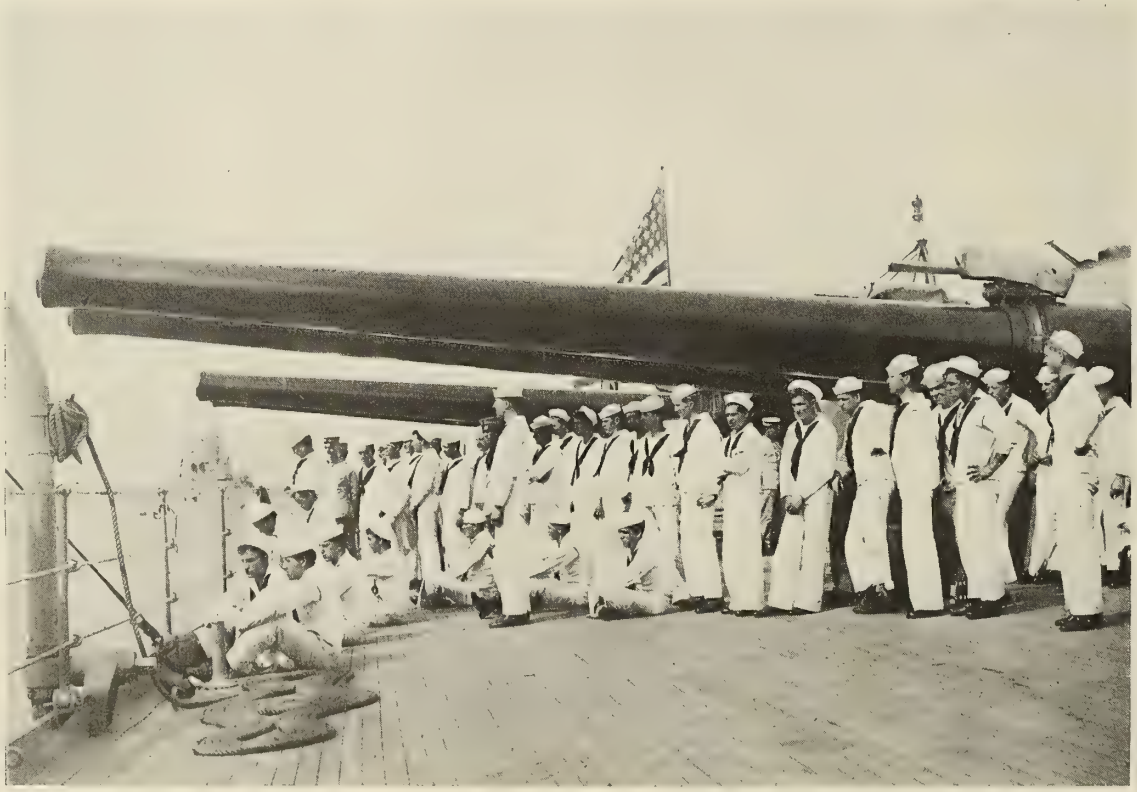
Forward Turrets



After Turrets

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

LARGEST CONTRACT SO FAR LET BY THE EMERGENCY FLEET CORPORATION

Seventy 8,000-Ton Fabricated Steel Ships to Be Built in One Year by the American International Corporation

Contract Involves Expenditure of Nearly $100,000,000

The American International Corporation, with headquarters at the Bellevue-Stratford Hotel, Philadelphia, which is to operate the Government fabricating shipyard at Hog Island, Philadelphia, has received the largest ship contract so far let by the Emergency Fleet Corporation. This contract calls for the building of seventy 8,000-ton fabricated steel vessels designed to have a speed of 15 knots.

The American International Corporation previously had a contract for fifty 7,500-ton vessels totaling about $50,000,000. The new contract makes it necessary for the corporation to turn out, if possible, within a year 130 vessels of over 1,000,000 tons deadweight carrying capacity, or more than the entire shipbuilding output of the United States in 1916.

Irving T. Bush Becomes Executive Head of New York Port War Board

Irving T. Bush, founder and head of the Bush Terminal Company, has been appointed executive head of the New York Port War Board by Secretary of War Baker. Under his direction all docks, boards, terminals and storage houses on the New York and New Jersey water fronts of New York harbor will be centralized and brought under federal control.

It is believed that with the present development the facilities of the port can be extended at least 25 percent by the elimination of useless competition. Since 80 to 90 percent of American exports must pass through New York harbor every effort will be made to remove obstacles in the way of an interrupted flow of supplies to Europe.

J. R. Flannery Given Charge of Housing Problem at Shipyards

J. R. Flannery, president of the Vanadium Steel Company, Pittsburgh, has been drafted into the service of the Shipping Board temporarily to assist in solving the housing problem at various shipbuilding yards. The most pressing needs just now are at the plants near Baltimore and Newport News, where accommodations are lacking for the hundreds of new workmen being pressed into service.

J. Barton Payne, of Chicago, who has been serving as counsel for the Shipbuilding Wage Adjustment Board, has become chief counsel of the Shipping Board Emergency Fleet Corporation.

REAR ADMIRAL CAPPS SUCCEEDED BY REAR ADMIRAL HARRIS

Ill Health the Reason for Admiral Capps' Resignation

Rear Admiral W. I. Capps, who has acted as general manager of the United States Shipping Board Emergency Fleet Corporation, since the resignation of Major General George W. Goethals, has been forced to relinquish his duties on account of ill health.

Admiral Capps' resignation was accepted with regret by the President, and the vacancy has been filled by the appointment of Rear Admiral F. R. Harris, chief of the Bureau of Docks and Yards of the Navy.

Great Lakes Engineering Works Building New Yard on Pacific Coast

The Great Lakes Engineering Works, Detroit, are erecting a new shipyard at Seattle for the purpose of building for the Emergency Fleet Corporation boats of about 9,400 tons deadweight capacity. The company's board has been reorganized, and President A. C. Pessano has become chairman, with offices in New York City. Other officers are: President, John R. Russell; vice-president and treasurer, H. W. Hoyt; vice-president and general manager, John A. Ubsdell; secretary, F. G. Morley.

The present contracts alone will average one ship every two weeks for delivery during the year 1918. The company has made important extensions to its three plants recently, spending in these improvements nearly $500,000.

Contracts for Twenty Steel Vessels of New Type Let by Shipping Board

The Shipping Board has placed contracts for the construction of twenty so-called unsinkable ships with the Foundation Corporation of New York. The vessels are of steel of about 4,000 tons, and will be constructed in a Southern yard.

The design of these vessels has been developed by a French naval constructor, and, roughly, consists of two horizontal cylindrical tanks placed side by side, decked over at top and bottom and fitted with ship-shape ends. The tanks are thoroughly sub-divided, and, it is claimed, offer maximum resistance to destruction by torpedo or mine attack.

SHIPBUILDERS ASK FOR REPRESENTATION ON COUNCIL OF NATIONAL DEFENSE

Petition Sent to President Wilson by Society of Naval Architects and Marine Engineers

Appointment of Representative Builder of Merchant Ships Suggested

American shipbuilders are unanimously agreed that the shipbuilding industry of the United States should have a representative on the Council of National Defense, where other important industries are now represented by recognized experts.

At the recent annual meeting of the Society of Naval Architects and Marine Engineers, the following petition was sent to the President of the United States, making an earnest appeal for the appointment of a representative builder of merchant ships as a member of the Council.

Whereas, Our country is assuming an increasing large proportion of the burden of carrying on the World War against autocracy; and

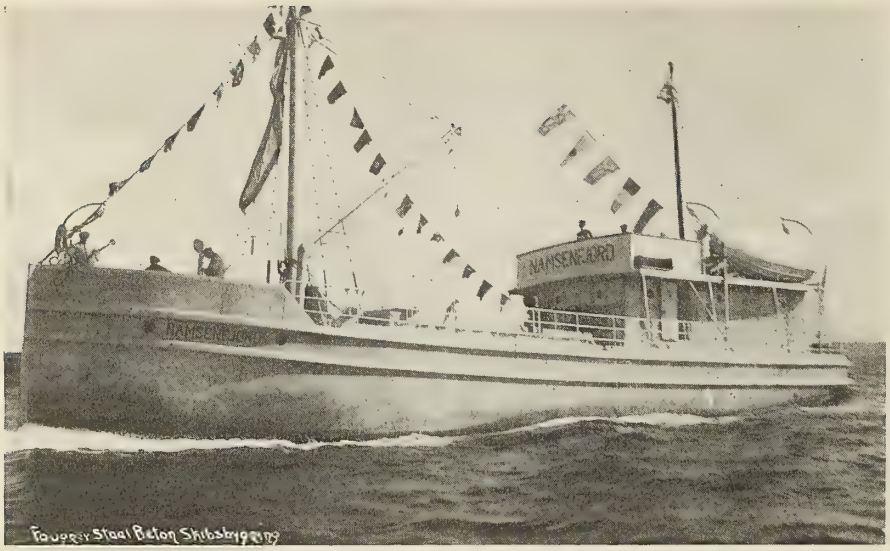
Whereas, the production of merchant ships to combat the losses sustained from submarine attacks, mines and other perils of the sea has become of paramount importance; and

Whereas, the assistance and co-operation of the most experienced shipbuilding talent in this country are required for the designing, building and equipping of ships, as well as for the direction of our shipyards, in order that the necessary ships may be quickly completed to meet the urgent needs of the hour; and

Whereas, at the present time, no experienced builder of merchant ships occupies any position where the counsel of such men is heard in the decision of national policies, while other important industries are now represented by recognized experts; be it therefore

Resolved, that the Society of Naval Architects and Marine Engineers, at its twenty-fifth assemblage in the city of New York, on November sixteenth, most respectfully and urgently petitions the President of the United States of America to appoint as a member of the Council of National Defense a representative builder of merchant ships who shall by reason of his experience, ability and business vision be qualified to sit in the high councils of that most important body.

(Signed) STEVENSON TAYLOR,
Lieutenant Commander U. S. N. R. F.,
President Society of Naval Architects and Marine Engineers.



Concrete Motorship *Namsenfjords*

Ferro-Concrete Motorship Namsenfjords

Through the courtesy of Mr. Nic. K. Fougner, president of the Fougner Steelconcrete Shipbuilding Company, Christiania, Norway, we are able to show on this page a view of the ferro-concrete motor ship *Namsenfjords*, which is the first sea-going vessel of this type which this company has built.

The vessel is 84 feet long, 20 feet beam, and on a draft of 11 feet 6 inches carries 200 tons of cargo. Propulsion is by an 80-brake horsepower Bolinder's engine giving a speed of 7½ knots. On trial the vessel behaved excellently in a seaway with practically no vibration discernible.

Shipyard Wages Fixed by Board

Uniform minimum wage scales for the Pacific Coast shipbuilding yards, a guide for all shipyards in the country, were announced in San Francisco on November 4 by the United States Shipbuilding and Labor Adjustment Board.

The decision effects an increase of from 10 to 30 percent over the old scale here, although its uniformity makes it lower in some localities than the temporary scale now in force.

"The Board found living costs had increased 36 percent. The men want enough to meet this."

The scale rates are retroactive, going back to the Puget Sound district to August 1. They must be put into effect on or before Monday, November 12, the Board ordered, and back pay must be paid within two weeks from that time. Rates of wages now being paid in excess of the minimum rates fixed are to be in no wise altered.

An eight-hour day was fixed for the San Francisco and Portland district.

The minimum scale, uniform for the Pacific Coast, was fixed as follows:

Journeymen machinists, molders, blacksmiths, anglesmiths, pipe fitters, boiler makers, ship fitters, pressmen, angle and frame setters, riveters, chippers and calkers, acetylene workers and electrical workers, $5.25 per day.

Painters and plate hangers, $5.

Sheet metal workers, coppersmiths and flange turners, $6.

Heaters, foundry carpenters, furnace men and punch and shear men, $4.50.

Patternmakers, $6.50.

Planer men, counter-sinkers, drillers and reamers and holders, $4.20.

Machinist specialist, $4.

Rivet heaters, $3.15, and laborers, $3.25.

Helpers are divided into two classes, as follows:

Machinists, pipe fitters, sheet metal workers, ship fitters, electrical workers, molders, helpers, $3.60.

Blacksmiths, coppersmiths, slab, plate hangers, hook tenders, flange fire and machine helpers and casting cleaners, $3.90.

In yards where wooden ships are being constructed the minimum rate for calkers is fixed at $6.50, shipwrights, joiners, boatbuilders and mill men, $6, and laborers and helpers, $3.25.

Examination to Establish a List of Eligibles for Enrollment as officers in the Civil Engineer Corps of the United States Naval Reserve Force

An examination, which will close at noon of December 31, 1917, will be held at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to establish a list of eligibles for enrollment in the Civil Engineer Corps of the United States Naval Reserve Force.

To compete in this examination it is only necessary for the candidate to address a letter to the Reserve Examining Board, giving full information as to his education and experience with testimonials and references. A descriptive circular giving detailed information for the requirements for this examination will be sent to interested parties upon request to the Chief of the Bureau of Yards and Docks, Navy Department, Washington, D. C.

Candidates recommended for enrollment will be authorized to appear before the nearest medical officer of the United States Navy for physical examination. Candidates found to be physically unfit will not be enrolled. A candidate must be an American citizen and must be an engineer in active practice of the profession of civil, electrical or mechanical engineering, or some business directly connected with these professions.

The age and experience requirements are for Ensign, not less than 24 years of age, with not less than two years of active professional practice; for Lieutenant (junior grade), not less than 27 years of age, with not less than five years of active professional practice; for Lieutenant, not less than 30 years of age, with not less than seven years of active professional practice, during at least three years of which candidate must have had responsible charge of work as principal or assistant.

Enrollments are for a period of four years, or during the existence of a war or national emergency. Except during a war or national emergency officers are only given active duty at their own request and then for short periods.

Pay and allowances of officers amount to approximately as follows:

Ensign, $2,100 per annum.

Lieutenant (junior grade), $2,500 per annum.

Lieutenant, $3,100 per annum.

There is an additional allowance of $150 per annum for uniforms.

Special Examinations for Cadetship U. S. Coast Guard

A special examination of candidates for cadetship (line and engineer) in the Coast Guard will be held at several of the large cities in the United States, depending upon the location of the candidates, commencing on Monday, December 17, 1917, and continuing throughout that week.

Regular examinations for these positions were held in June, but there were not a sufficient number of qualified candidates to fill the existing vacancies. It is hoped to secure a total of at least twenty cadets and cadet engineers at this special examination.

Candidates for cadets (line) must be not under 18 nor more than 24 years of age, and those for cadet engineer not under 20 nor more than 25 at the date of appointment, which will be on or about Janury 15, 1918. Line cadets undergo three years of instruction at the Coast Guard Academy, New London, Conn., upon the successful completion of which they are commissioned third lieutenants in the Coast Guard, which grade is assimilated to that of ensign in the navy and second lieutenant in the army. The pay of a line cadet is $500 a year, plus commuted rations at the rate of 45 cents a day. Cadet engineers undergo instruction for one year at the academy and receive $75 a month and commuted rations. Upon successfully completing their course they are commissioned third lieutenants of engineers. Third lieutenants, both line and engineer, receive pay at the rate of $1,700 a year, and officers commissioned in these grades are in the line of promotion to higher rank and pay.

By the terms of the Act of June 28, 1915, the former Revenue Cutter Service and Lifesaving Service were combined into the newly-created Coast Guard, which performs all of the functions formerly pertaining to the component services. In time of war or emergency the Coast Guard operates under the Navy Department as a part of the navy, but at other times it operates under the direction of the Secretary of the Treasury.

Pamphlets giving full information and samples of previous examinations, as well as blank forms for application, may be had by addressing the Captain Commandant, United States Coast Guard, Washington, D. C.

NEW SHIPBUILDING COMPANIES ORGANIZED

Additions and Improvements to Shipbuilding Plants

The St. Louis, Mo., Chamber of Commerce has taken steps for the organization and establishment of a $1,000,000 shipbuilding corporation, to be devoted chiefly to the construction of barges, tugboats, etc., but which will also be equipped to build warships of light draft.

The Three Rivers Shipyard Company, Ltd., has been organized at Toronto, Canada, by Thomas Mulvey Kirkwood. The bonds of the company are guaranteed by the City of Three Rivers, Canada. It is stated that the yard will build wooden ships, at a cost of about $450,000 each.

The Mobile Shipbuilding Company has been organized at Mobile, Ala., by W. L. Kelly and MacR. Fife, of the Kelly-Atkinson Company, general offices, 189 West Madison street, Chicago, Ill. The new company will build single-screw composite cargo carrying steamers for the Emergency Fleet Coropration.

Thomas H. Wright, C. C. Chadbourn and Charles E. Taylor, Wilmington, N. C., are planning to build a shipyard on the Cape Fear River.

Ernest Strauss will enlarge his shipyard at Harrisburg, Tex.

Morey & Thomas, Jacksonville, Fla., have given a contract to the T. C. Dawkins Company, Jacksonville, for the erection of machine shops, offices, etc., for their new shipyard.

Heldenfels Bros., Beeville, Tex., will build a shipyard at Rockport, Tex. They are reported to have received a contract to build several wooden vessels for the Emergency Fleet Corporation.

The Ampco Shipbuilding Company, Security building, Milwaukee, is planning to build a shipyard and drydock in Milwaukee.

The Motor Ship Construction Company, Vancouver, Wash., which has contracts for more than 300 lifeboats and rafts, is enlarging its plant.

The plant of the Risdon Iron Works, San Francisco, Cal., has been commandeered by the Government and will be greatly enlarged.

Horace Turner, president of the Turner Terminal Company, Mobile, Ala., is planning to build a shipyard.

The Pelican Motor Ship Company has been incorporated to build a shipyard. M., P. H. and C. Zornow, 1270 Broadway, New York, are the incorporators.

The Manistee Shipbuilding Company, Manistee, Mich., has made a large investment in machinery to repair old boats.

The Biddeford Shipbuilding Company has been incorporated by E. L. Morrill, Saco, Me., George C. Fogg, Biddeford, Me., and others.

The Hoosac Lumber Company has been incorporated to build ships. Huntington P. Faxson, Cambridge, Mass., is president.

The Barge & Lighter Repair Company has been incorporated to operate a boat works. John H. Patterson, William N. Sewell and Chas. J. Gormley, of Jersey City, N. J., are the incorporators.

The Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, New York, have prepared plans for the construction of three shipways at 177th street and Harlem River.

The Clinton Shipbuilding & Repair Company has been incorporated. F. J. Bradley, Philadelphia, Pa., is treasurer.

Grant-Smith-Guthrie-McDougall, Portland, Ore., is planning the construction of another shipyard.

The Puget Sound Machinery Depot, Seattle, Wash., has purchased land, in which it will, so it is reported, erect a plant to cost $1,000,000, where it will manufacture patterns for ship machinery, boilers, shafting, etc.

The Tide Water Shipwrights, Inc., has been organized by M. P. Wheeler, W. Brown and L. W. Davidson, 18 Christopher street, New York.

The Donohoe-Rathbone Shipbuilding Company has been organized in Seattle, Wash., to build wooden vessels.

The Ames Shipbuilding & Dry Dock Company, Seattle, Wash., has bought water-front property on which it will erect another shipbuilding plant.

It is reported that the Southern Pacific Company, San Francisco, Cal., contemplates the erection of a shipbuilding plant near Alameda.

The Erickson Engineering Company, Seattle, Wash., has been incorporated, and is building shipways on the Duwamish River.

The William Cramp Ship & Engine Building Company, Philadelphia, has purchased the De La Vergne Machine Company's plant, covering about 5½ acres in New York City, for building engines.

A shipbuilding plant has been established on the Ala Moana beach, half a mile distant from the Honolulu Iron Works, Honolulu, where three schooners are now being built.

Enlargement of the Skinner & Eddy shipbuilding plant is proceeding at Seattle. Two big outfitting wharves, each 850 feet long and 65 feet wide, are being built in the added area of the site. Between them a 125-foot slip is being dredged to a depth of 30 feet. On the north side of the No. 2 wharf there is to be another 125-foot slip. In reality the two slips will be huge outfitting basins. The site now contains 27 acres. The additions to the plant will cost approximately $1,000,000, and when they are completed the yards will represent an investment of more than $4,000,000. The plant's launchings this year will total 11, and 16 launchings are now lined up for 1918.

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S. S. *Rochester*, Recently Sunk by German U-Boat

Shipbuilders Awarded Contracts for New Vessels

The American International Shipbuilding Corporation, which is to operate the Government yard at Hog Island on the Delaware River, has been authorized by the Emergency Fleet Corporation, Washington, D. C., to build seventy 8,000-ton steel steamers within twelve months from the completion of the yard. The temporary office is in the Bellevue-Stratford Hotel, Philadelphia, Pa.

The Jancke Navigation Company, New Orleans, La., has received a contract from the Emergency Fleet Corporation, Washington, D. C., to build twelve 5,000-ton steel ships. It is stated that all these ships will use fuel oil.

The Southern Shipbuilding Company has secured a site on the Cooper River, near Charleston, S. C., and will build steel steamships. It is understood that the company has received a contract from the Emergency Fleet Corporation to build a large number of these vessels. H. N. Whittelsey, 17 Battery Place, New York, is president of the company.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., is building

Fig. 1.—Shipyard of Bagdad Shipbuilding Company, Showing Auto Crane in Operation

two 3,500-ton steel steamships from plans by J. W. Millard & Bro., 17 State street, New York.

The Eastern Shore Shipbuilding Corporation, Sharptown, Md., is building a wooden schooner for Theodore B. Johnson, 17 Battery Place, New York.

The Hampton Roads Dry Dock Corporation, Hampton Roads, Va., is reported to have received a contract from the Emergency Fleet Corporation to build four steel steamships.

It is reported that the American Shipbuilding Company, Portland, Ore.; the Pacific Shipbuilding Company, Seattle, Wash., and Meacham & Babcock, Seattle, Wash., have been authorized by the Emergency Fleet Corporation to build wooden vessels for the French and British Governments.

It is reported that the Elliott Bay Shipbuilding Company, Seattle, Wash., has received contracts to build several ocean-going wooden motor boats.

The Daniels Construction Company, New York City, is reported to have received a contract from the Emergency Fleet Corporation to build twelve 9,500-ton steel steamships in a plant to be erected near Brunswick, Ga.

The Emergency Fleet Corporation has placed a contract for four cargo boats with the Newburgh Shipyards, Inc. It is understood that each of these ships will be of 5,000 tons deadweight.

A contract has been let by the United States Shipping Board to the Hampton Roads Dry Dock Corporation to build four steel ships of 7,300 tons capacity each.

Byers' Shipbuilding Auto-Cranes Installed by Bagdad Shipbuilding Company

The Bagdad Shipbuilding Company, Milton, Fla., has recently put into operation one of the shipbuilding auto-cranes manufactured by the John F. Byers Machine Company, Ravenna, Ohio. The crane is self-propelling, and is mounted on rail trucks for operation on tracks laid alongside the shipbuilding berths. The crane is fitted with a 40-foot beam, and has a capacity as a derrick of 4,500 pounds at a 20-foot radius. The crane is operated by a steam Byers' locomotive crane-type engine of 25 horsepower and has a propelling speed of 200 feet per minute. The total weight of the crane is 14 tons, and it is mounted on a two-wheel rigid truck at the front end and a four-wheel swivel truck at the rear end.

These cranes can be furnished with gasoline (petrol) or electric power, and mounted on road wheels, if desired. The shipbuilding crane can be speedily changed to accommodate a clamshell or orange-peel bucket for excavating work or for rehandling loose material. The cranes are equipped with two or three drums, as desired, or a three-drum can be added in the field.

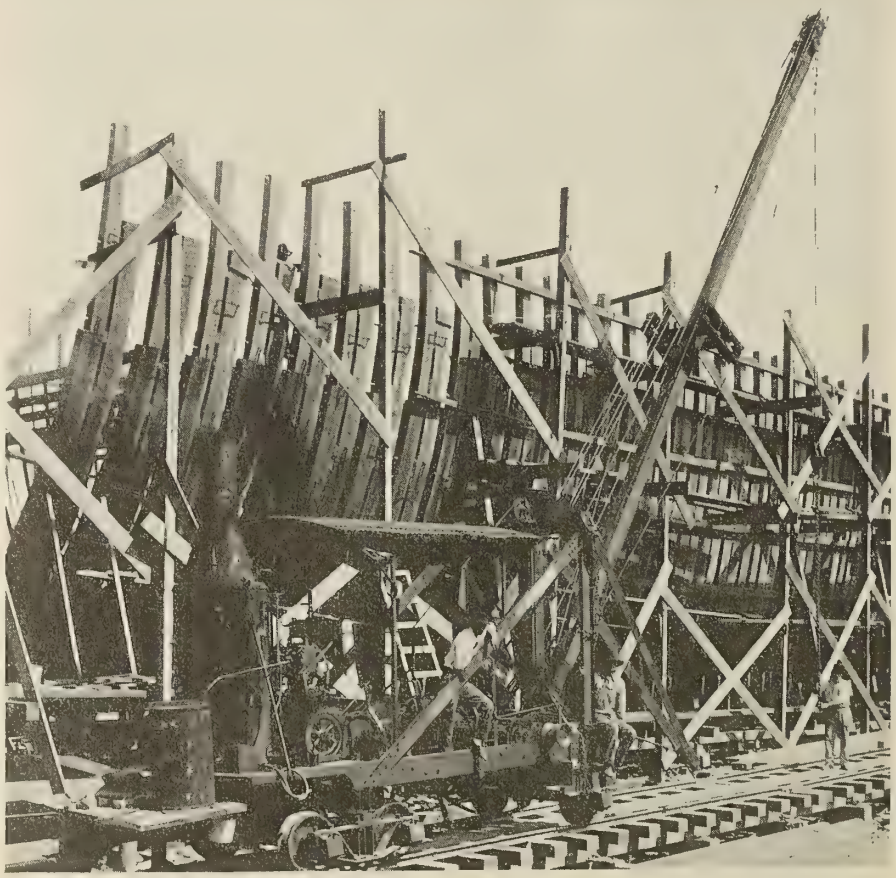


Fig. 2.—Byers' Shipbuilding Auto-Crane

Sun Shipbuilding Company Launches Its First Vessel

The Sun Shipbuilding Company, Chester, Pa., launched on October 30 its first vessel, the 10,000-ton bulk oil steamer *Chester Sun,* built to the order of the Sun Company, of Philadelphia. The vessel is 445 feet long over all, 430 feet between perpendiculars, 59 feet molded beam, and 33 feet 3 inches molded depth, with a gross tonnage of 6,683 and an indicated horsepower of 2,500, designed to give a service speed of 10½ knots with the vessel carrying 10,300 tons on a draft of 25 feet 6 inches.

The vessel is of the three-island type, having complete main and upper decks, expansion trunk and poop, bridge and forecastle decks of steel. The main cargo space is divided into nine tanks on each side, which, together with the summer tanks, give a total cargo capacity of 3,300,000 gallons. Fuel oil tanks, with a total capacity of 380,000 gallons, are also provided.

Propulsion is by a triple-expansion engine with cylinders 27 inches, 45½ inches and 76 inches diameter by 51 inches stroke, supplied with steam at 190 pounds per square inch working pressure by three single-ended Scotch boilers, 15 feet 3 inches diameter by 11 feet 5 inches long. The usual auxiliaries are fitted, including two large cargo oil pumps located in the pump room amidships. The vessel has been requisitioned by the Emergency Fleet Corporation.

Following the launching an elaborate luncheon was served in the mold loft of the yard to a large company of guests who witnessed the ceremony, Mr. S. Howard Pew, president of the Sun Shipbuilding Company, presiding as toastmaster.

Recent Launchings

At Gloucester City, N. J., on November 10, the Pennsylvania Shipbuilding Company launched the 7,000-ton oil tank steamer *John M. Connelly.*

At Seattle, on November 6, J. F. Duthie & Company launched the 8,000-ton deadweight freighter *Hallbjorg,* built for Norwegian account.

At Ecorse, Mich., on October 30, the American Shipbuilding Company launched the 12-000-ton lake bulk freighter *August Ziesing.*

On November 1, sixty-four days from the day of laying the keel, Skinner & Eddy launched the 8,800-ton steel freighter *War Flame,* which is the eighth ship this yard has turned out this year. The *War Flame* was ordered by the Cunard Line for Chambers & Company, of Liverpool, but she has been commandeered by the Government.

Navy Department Calls for 7,000 Firemen by December 15

The Navy Department has sent telegrams to its recruiting officers in all parts of the country directing them to begin an active campaign to enlist 7,000 firemen by December 15. The quotas assigned for the various districts are: Eastern district, 2,000; central, 2,000; southern, 1,000; western, 2,000.

For firemen men from 18 to 35 years of age will be accepted. No previous experience in firing is required, but men must be physically qnalified for the work.

Courses in Naval Architecture and Marine Engineering Established at Polytechnic Institute of Brooklyn

To meet the demand for professionally-trained shipyard employees, the Polytechnic Institute of Brooklyn has established evening courses in naval architecture and marine engineering. These courses aim to give the students such a comprehensive training that when they enter a shipyard or a ship drawing office, they will understand what is wanted of them and how to proceed in accomplishing it. Additional and advance courses leading to the degree of Bachelor of Science in marine engineering and naval architecture may be offered later.

The courses are in charge of A. Mathies, a graduate of the University of Michigan, who is connected with the Federal Shipbuilding Company of New York, and holds a commission in the United States Naval Reserve Force, and Dan D. Gardner, also a graduate of the University of Michigan, who is at present boiler designer for the Federal Shipbuilding Company of New York.

"Victory" Plant Being Pushed to Completion

The new $9,000,000 destroyer plant which the Bethlehem Steel Corporation are having built at Fore River by the Aberthaw Construction Company is rapidly taking shape. In addition to the main plant, work is going forward on Victory Plant No. 2 at Buffalo, which is to be occupied by the Bethlehem Steel Corporation about January 15. In this plant the turbines are to be made for the destroyers.

The Buffalo plant will occupy 15 acres of land, near Tonawanda, and the main building will be 750 feet by 200 feet, with a boiler house and administration buildings added. The construction throughout will be of steel and concrete, over 1,500 tons of steel being used in the construction, and will require 3,000 men.

The cost of the construction of this plant, aside from that at Squantum, will be $1,500,000. Power for the operation of this plant will be furnished by a new power house recently erected at Buffalo by Stone & Webster ,of Boston.

L. C. Manuell, representing the Bureau of Yards and Docks of the Navy Department at Washington, represents the Government at this plant and has general supervision of the work.

Davis Shipyard Reorganized and Enlarged

The shipbuilding partnership of M. M. Davis & Son, at Solomons, Md., and Moses, Pope & Trainer, engineers, of New York City, have joined forces and incorporated the yard under the name of M. M. Davis & Son, Inc. The officers of the new company are: President, M. M. Davis; vice-president and manager, Clarence E. Davis; secretary and treasurer, J. N. Trainer, Jr. A New York office has been opened at 366 Fifth avenue, New York City.

Ample capital has been secured with which to enlarge the yard and take on new work in addition to the present construction on the barges and towboats for the Bethlehem Steel Company, and the Northern Transportation Company of Baltimore. The forces will be increased at once.

PERSONAL

HUGO FREAR, formerly with the Union Iron Works, San Francisco, Cal., has been appointed naval architect of the Bethlehem Shipbuilding Corporation, which will have charge of all the designing work for the various shipyards owned by the Bethlehem Steel Company.

H. E. LEWIS, formerly assistant to the president of the Bethlehem Steel Company, has been elected vice-president of the company.

E. B. HILL, formerly treasurer of the Fore River Shipbuilding Corporation, Quincy, Mass., has been elected treasurer of the Bethlehem Steel Company.

WILLIAM G. COXE, president of the Harlan & Hollingsworth Corporation, Wilmington, Del., has resigned on account of ill health.

DUDLEY R. KENNEDY, formerly assistant to the president of the Youngstown Sheet & Tube Company, has been appointed head of the Department of Industrial Relations of the American International Shipbuilding Company, Philadelphia.

WILLIAM P. ROTH has been elected vice-president and general manager of the Matson Navigation Company, San Francisco, Cal.

CAPT. E. O. PATTERSON has been appointed by the United States Shipping Board as resident inspector in charge of the steamships building by the Cumberland Shipyard, Portland, Me.

JAMES MONTGOMERIE, who has been principal surveyor of Lloyd's Register of Shipping at Glasgow since May, 1916, has been appointed Lloyd's Principal surveyor for Scotland.

E. B. EGBERT has been appointed hull and machinery inspector for the United States Shipping Board Emergency Fleet Corporation, with headquarters at Portland, Ore.

CAPT. LEWIS S. JORDAN, former assistant United States inspector of hulls, is now surveyor of hulls for the American Bureau of Shipping in the Washington-Oregon district.

L. E. GEARY, of Seattle, has been appointed naval architect for the United State Shipping Board's Seattle district.

D. W. KALLIS, former chief of the hull drafting office of the Seattle Construction & Dry Dock Company, is employed in the office of the United States Shipping Commission at Seattle. He has been succeeded by J. K. Ingham.

P. S. STONE, for a number of years chief draftsman in the office of the United States Naval Constructor at the yard of the Seattle Construction & Dry Dock Company, has accepted the position of naval architect for the Patterson-McDonald Company, of Seattle. Oscar A. Seigley is the new chief in the Naval Constructor's office.

PROF. C. D. SHANE is in charge of a school of navigation which has been opened in Bellingham, Wash.

CAPT. WILLIAM FISHER has been appointed inspector of hulls for the Seattle district, to succeed Capt. B. B. Whitney, now head of the American Bureau of Shipping in Washington and Oregon.

OBITUARY

WILLIAM D. KEARFOTT, president of the Kearfott Engineering Company, New York, died from apoplexy at his home in Montclair, N. J., on November 12, at the age of 53 years.

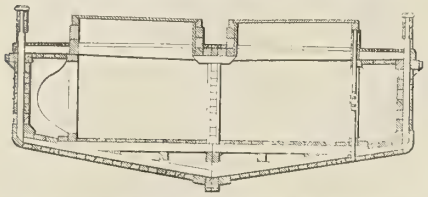
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,228,922. WOODEN BOAT. EDWARD S. HOUGH, OF OAKLAND, CAL.

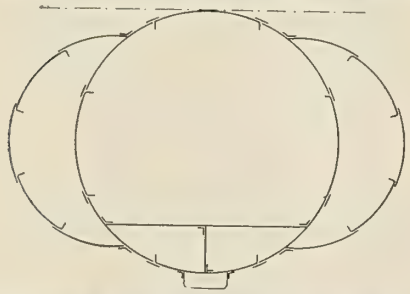
Claim 1.—A ship frame in wood comprising a plurality of transverse bottom members of straight timbers meeting each other at the medial line of the vessel at their inner ends, substantially vertical side ribs of straight tim-



bers, secured at the outer ends of said bottom timbers, transverse floor timbers secured at their outer ends to said bottom timbers, and longitudinal stringers intermediate of said bottom timbers and floor timbers. Three claims.

1,229,004. CONSTRUCTION OF SUBMARINE VESSELS. HAROLD EDGAR YARROW, OF SCOTSTOUN, GLASGOW, SCOTLAND.

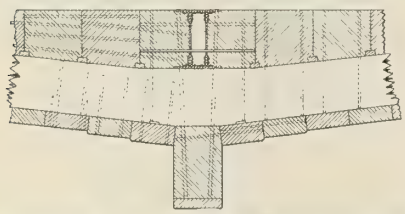
Claim 1.—In a submarine vessel, of the type in which the hull is approximately in the form of a tube of annular cross section, external plates connected by longitudinal and transverse



butt straps adapted to sustain, without the addition of transverse frames, the bending moments and external pressure to which the vessel is exposed, substantially as described. Three claims.

1,229,413. SHIP CONSTRUCTION. RICHARD CHILCOTT, OF PORTLAND, ORE.

Claim 1.—In ship construction, in combination with the floor ceiling timbers and keel, a steel girder extending lengthwise of the ship above the keel thereof and having its top plate



substantially flush with the top surface of the floor, holding bolts extending through the web portion thereof and the floor timbers at the opposite sides, and holding bolts connecting said girder and said keel, substantially as described. Five claims.

1,224,678. MARINE VESSEL. ERNEST L. SONS, OF PITTSBURG, PA., ASSIGNOR OF ONE-HALF TO SAMUEL A. BOYD AND ONE-FOURTH TO WILLIAM L. McCANDLESS, BOTH OF PITTSBURG, PA.

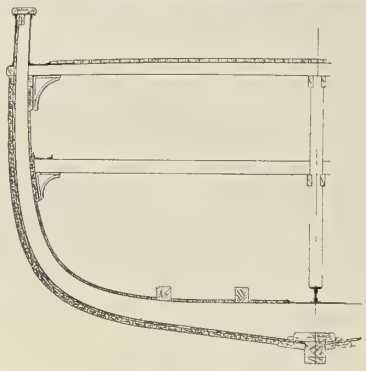
Claim 1.—A marine vessel comprisng a hull including an inner and outer frame and further having a deck floor formed of an upper and lower section, a series of independent rows of air containing casings interposed between said frames, a series of independent rows of air containing casings interposed between said floor sections, each of said casings having one wall depressed to provide a longitudinally extending groove, an inlet valvular device mounted in the bottom of each of said grooves, and a series of independent air supply pipes, each of said pipes common to a row of casings, positioned in the grooves of and connected to the valvular device of the casings of the row. Two claims.

1,228,914. APPARATUS FOR RAISING SUNKEN SHIPS. EUGENE S. HAYFORD, OF NEW ORLEANS, LA.

Claim 1.—An apparatus for raising sunken ships, including a collapsible and inflatable envelop, means for supplying air thereto, and an auxiliary inflatable envelop mounted therein and constituting a buoyant support for the main envelop. Four claims.

1,231,232. SHIPBUILDING. FRED A. BALLIN, OF PORTLAND, ORE.

Claim 1.—In a wooden ship, a metal bulwark plate above the main deck line that forms a member of a top chord of a truss, diagonally



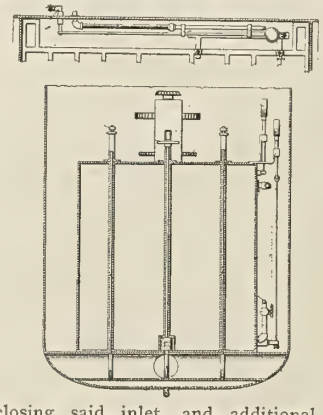
disposed planking and wooden frame sections that form the sheer members of the said truss and means for joining the several parts together with the bulwark plates exposed. Nine claims.

1,232,619. SHIP STABILIZING AND ROLLING APPARATUS. ELMER A. SPERRY, OF BROOKLYN, N. Y., ASSIGNOR TO THE SPERRY GYROSCOPE COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A stabilizing device for ships and other devices subject to similar oscillations comprising a gyroscope, and means brought into action by precession of the gyroscope for exerting a stabilizing effect upon the ship. Thirty claims.

1,232,667. SUBMARINE VESSEL. ALPHONSE FERNANDEZ, OF WASHINGTON, DISTRICT OF COLUMBIA.

Claim 1.—A submersible vessel having a plurality of longitudinally spaced submerging chambers, a water passage extending longitudinally of the vessel and having a water inlet at or near the center of the latter, valve means



for closing said inlet, and additional valve means for closing said passage on either side of said inlet to exclude water from either end of the ship. Ten claims.

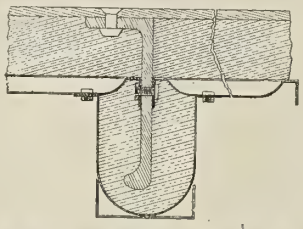
1,227,285. DRAFT INDICATOR. JOHN MAHER, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-FIFTH TO EUGENE QUIGLEY AND ONE-FIFTH TO JOHN J. McKEE, BOTH OF CLEVELAND, OHIO.

Claim 1.—A draft indicator comprising the combination with a vessel, of a scale having graduated indicia corresponding with the depth of the hull, a member supported adjacent said scale and provided with openings spaced as said indicia, and a water gage communicating through said hull, said gage carrying projections adapted to co-operate with different pairs of such openings whereby an adjustment in the direction of alinement of said graduations may be effected. Twelve claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

107,078. "IMPROVEMENTS IN AND CONNECTED WITH THE FITTING OF ASBESTOS INSULATION IN ALL CLASSES AND PARTS OF SHIPS." A. BEAN, OF 1, SHANDON STREET, GOVAN, GLASGOW.

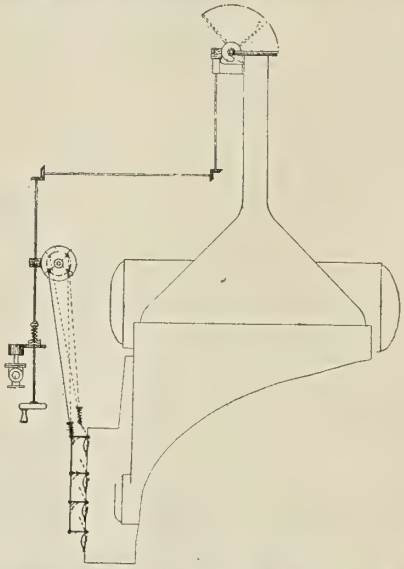
The invention relates to the fitting of asbestocel insulation, by which is meant hard or slate-faced asbestos insulation in all classes and



parts of ships, and has for its object to simplify the method of fixing the asbestocel slabs in position and to prevent the sagging of the same. With this invention, all cementing and plastering when the insulation is being fitted is dispensed with.

108,416. IMPROVEMENTS RELATING TO SUBMARINE VESSELS. H. E. YARROW, OF MESSRS. YARROW & COMPANY, LIMITED, OF SCOTSTOUN, GLASGOW, SCOTLAND, ENGINEER.

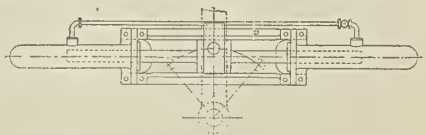
The invention relates to the closing of the top of the funnel of a submarine vessel when it is intended to submerge the vessel. A hinged valve is provided which can be operated from within the submarine to close the funnel



aperture when the vessel is submerged, and the means operating the valve are, either, so arranged that at the first motion the oil fuel is shut off from the burners, the air doors are then closed to prevent the products of combustion from escaping into the stoke-hole, and finally the funnel aperture is closed to prevent access of water, or these operations are performed simultaneously.

107,346. "SHOCK REGISTER FOR SHIP'S STEERING GEAR." F. O. STOREY, 9, SYDENHAM ROAD, STOCKTON-ON-TEES.

The object is to improve the method of resisting the shock produced by the action of the sea on the rudder of a ship. A crosshead, having two projecting rams, one at each side,



which enter into the hydraulic chambers, moves in a guide and is connected to the tiller or quadrant by means of a sliding socket pivoted on a pin secured to the tiller or quadrant.

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"Colder than ever, and a head wind"

That's the time when the "Chief" has plenty to worry about.

But all his worries center on one point—*keeping up a good head of steam in the engine-room.*

Shoveling extra coal won't do it unless the pipes and boilers are properly protected against heat-losses.

"85% Magnesia" coverings on pipes and boilers insure a plentiful supply of steam regardless of weather conditions.

They save coal by preventing heat-losses. They deliver hot, dry, expansive steam to the engines. They make work easier in both stokehold and engine-room.

When repairs are needed, the "85% Magnesia" coverings are easily removed and replaced without damage—and with proper care will probably last as long as the pipes and boilers themselves.

For all these reasons, "85% Magnesia" covering should be specified for all new construction or renewals.

"85% MAGNESIA"

The Universal Covering for Pipes and Boilers

MAGNESIA ASSOCIATION OF AMERICA, 702 BULLETIN BLDG., PHILADELPHIA, PA.

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TRADE PUBLICATIONS

"Turning Waste Into Profit" is the title of a new book just issued by The Prest-O-Lite Company, Inc., 818 Speedway, Indianapolis, Ind. It is devoted exclusively to the possibilities of reclaiming broken and worn machinery and metal parts for service by the oxy-acetylene process, and is the most complete and comprehensive book ever issued on this subject. Containing eighty-two illustrations, it pictures and describes representative examples of reclamation welding work in practically every field of the industrial world. In the face of present high prices and scarcity of metal equipment, the subject of welding is receiving more than usual consideration, and this new book is truly a beacon to plant owners interested in the efficiency of holding down the "scrap heap." It is mailed to any interested executive upon request.

"How to Repair Broken Aluminum" by the Alumnite Process is described and illustrated in a circular published by the Alumnite Manufacturing Company, Inc., 427 Fourth avenue, New York. "Perfect results can only be obtained with Alumunite by following these directions: Cleaning: Thoroughly clean the edges of the metal which are to be soldered together. The best way to accomplish this is to first wash the surfaces with gasoline and rub them vigorously with a wire scratch brush. After the gasoline has thoroughly evaporated dress the edges down with a file, so as to get a perfectly clean, new surface. Again apply the gasoline and the scratch brush. The surfaces are now ready for "tinning." Tinning: The best way to tin the surfaces after the cleaning process, if the surfaces be large and of cast aluminum, is to apply the scratch brush vigorously and raise the temperature of the metal with a blow torch until the solder melts freely upon the edges to be joined and shows the tendency to adhere. While still applying the torch, continuously brush the solder into the joint until the joint shows a perfect plating or thin coating of the solder. Repairing: The work is now ready to be united. To do this, where it is convenient, lay the work upon a metal plate and place between it and the plate a piece of asbestos of about one-eighth inch fit. Bring the joints of the repair which are to be soldered against each other. Again apply the torch and melt some of the solder in a pasty form into the crack between the joints. Use an old hack saw blade, or similar thin piece of metal, to work the solder into the crack, and keep this process up until the entire crack is filled. The surrounding edges may be smoothed off while soft by 'wiping' or smoothing with the hack saw blade."

"Agrippa" Tool Holders are among the drop-forged machinists' tools described in a 28-page illustrated catalogue published by J. H. Williams & Company, 63 Richards street, Brooklyn, N. Y. "Unusual precaution has accompanied the development of this line of holders. Every detail has been tested and given closest possible attention. Materials best adapted to each of its parts have had every consideration and variety of test. The design, with the thought of its fullest utility and non-obstructive character, has had abundant and purposeful care. The holders or shanks, all drop-forged from a strong, tough grade of carefully selected steel, are submitted to a special heat treatment or refining process after forging, which develops resistance to all wear and the great strength necessary to overcome the pushing thrust imposed upon the cutters. The cutter-holding channel provides an unusually strong seat for cutter and great resisting qualities for the work imposed upon this portion of holder—a fundamental requirement in tool-holder efficiency. The 'Agrippa' cam fastening, which features the turning, cutting-off and side and threading-tool holders, is furnished from hardened and tempered crucible tool steel in either headless or hex head form. This simple and most efficient fastening largely eliminates the trouble and faults common to other holders. It is indestructible, provides for strength 25 to 50 percent greater than that of fastenings used similarly, and removes the repair and replacement necessities so common in other varieties of holders. The 'Agrippa' bar cutters, made from high-speed, etc., steels of selected grade, are all cut to the 'diamond point' form or bevel. They thus provide for the most common requirements with a minimum of grinding for either right or left-hand usage; also the full extent of economical service that distinguishes this superior line of tool holders. Special features of superiority and individuality applying to each holder are detailed on their respective tool pages immediately following."

Bulletin S-1, describing electric hoists, has just been published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. "The cost and scarcity of labor and the difficulty of keeping men at heavy lifting work, has developed an insistent demand for electric hoists for handling loads of ¼ ton, ½ ton and 1 ton. To meet this demand we have added three sturdy little hoists of these capacities to the Shepard line. They are helping progressive manufacturers to increase production, to reduce handling costs and to retain men in these jobs. Like the larger machines in the Shepard line these hoists have bath oiled gearing and brakes, enclosed within the frame. This design permits bath lubrication and excludes all dirt. The balanced drive insures permanent alignment. The prices quoted are for single speed control only. For prices on hoists equipped with variable speed control apply to the address on the first page. We are producing these hoists, with perfected tools, in such large quantities that even in these busy times shipment can usually be made from stock."

Snow Oil Pumps are described and illustrated in Bulletin S-112, just issued by the Worthington Pump & Machinery Corporation, 115 Broadway, New York. Among the other products of the Worthington Pump & Machinery Corporation are the following: Accumulators, air pumps, automatic feed pumps and receivers, ballast pumps, barometric condensers, beer meters, centrifugal pumps, central condensing systems, check valves, cooling towers, disc meters, dry vacuum pumps, elevator pumps, electric pumps, feed pumps, fire pumps, foot valves, fuel oil pumps, high-duty pumping engines, hot water meters, house tank pumps, jet condensers, low steam pressure pumps, mine pumps, oil line pumps, oil meters, piston meters, pressure pumps, self-cooling condensers, sinking pumps, steam turbine condensers, strainers, surface condensers, tank pumps, triple expansion pumping engines, turbine pumps, turbine water meters, underwriter fire pumps, vacuum pumps, volute pumps, water works pumping engines, water meters, wet vacuum pumps. Special catalogues will be furnished upon application.

"The Cost Cutter" is the title of a bulletin published by the Brown Portable Conveying Machinery Company, Chicago, Ill. "The trend of the age is toward efficiency and economy and against wasteful and non-productive expenditure. The handling of your finished products—the trucking and piling of your sacks, cases, crates, bales, barrels, etc., is an expense that produces nothing—that merely adds to your cost without giving you an adequate return in either quality of goods or selling price. Inefficient methods in handling your products waste your money and reduce your profits. This problem of non-productive labor—an expensive, yet imperative evil—is solved, or simplified, by the Brown portable elevating, conveying and unloading machines—portable, sectional, adaptable, reliable, economic, efficient—machines that transform waste into profit. Let us get together on this matter, let us show how we can save you money, approximately how much we can save you, and what it will cost you—if we can't save money for you we will tell you so. We want to serve you; we want to provide for your individual needs; we are prepared to meet the efficiency requirements of your plant just as we have met those of others in all parts of the world. We have made profits for many industrial concerns, large and small, for railroads, steamer lines, municipalities and others, and believe we can do the same for you. It costs you nothing to investigate and does not obligate you in any way."

Landis Threading Machinery is described and illustrated in a 78-page catalogue just issued by the Landis Machine Company, Inc., Waynesboro, Pa. "In this catalogue we invite your attention to the Landis die and shall discuss its worth from a viewpoint of economy, production and efficiency. Accordingly, we submit for the reader's consideration those characteristics which substantiate our claims for longer life, increased output, low cost of upkeep and greater accuracy. The conception, as well as the development of the Landis die, was the natural outcome of the endless difficulties encountered with the hobbed type die. The fundamental principles to which its superiority is attributed depart widely from those of other designs. We have not only incorporated every feature contributive to economical production, but have eradicated the inherent defects and weaknesses of other types. Since the last isue of our catalogue we have perfected a line of pipe threading and cutting machines and have developed a grinder suitable for our chasers. This catalogue is devoted almost exclusively to a description of Landis bolt and screw cutting machinery. It also treats in a cursory manner of the Landis pipe and nipple machine and the Landis pipe threading and cutting machine. For detailed information concerning these machines and their accessories we are pleased to refer you to our Catalogue No. 23, which will be gladly sent upon request."

When writing to advertisers, please mention INTERNATIONAL MARINE ENGINEERING.

Westinghouse Marine Equipment is the subject of a bulletin issued by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. One of the illustrations in this bulletin shows the engine room of the steamship *Hisco*. She is one of a large number of ships now under construction at the Chester Shipbuilding Company's yards, all of which are to be equipped with Westinghouse propelling machinery.

"Steel Pipe and Progress" is the title of a bulletin published by the National Tube Company, Pittsburg, Pa. We quote as follows, leaving out the illustrations:

The wonderful and rapid development of the steel pipe industry within recent years reads like a romance or a tale from the "Arabian Nights' Entertainments." It is indeed a romance—an industrial romance, in which the leading character—wrought pipe—has made possible the efficient development and expansion of hundreds of industries.

Often the term "wrought pipe" is mistaken by consumers and others to apply to wrought iron only, but this term is generic and applies to either wrought steel or wrought iron pipe. Its correct use in specifications and elsewhere means that either wrought steel or wrought iron pipe may be furnished.

Prior to 1888 all wrought pipe was made from wrought iron skelp, and to this may be attributed, no doubt, the occasional misinterpretation of the term. However, in that year experiments with soft mild steel for wrought pipe manufacture proved so successful that wrought steel pipe soon became widely used in place of the older wrought iron pipe. In fact, the consumer quickly discovered that the new soft steel pipe possessed the good qualities of the old wrought iron and in addition was superior in physical properties.

The production of wrought steel pipe grew by leaps and bounds, and soon became a most important factor in the wrought pipe industry. By 1905 the production reached such large proportions that the American Iron and Steel Institute considered it advisable to compile separate statistics showing the relative production of these two materials. In that year the tonnage of wrought steel pipe was more than twice as great as that of wrought iron, and since then it has been constantly increasing. The following table shows the tonnage production of steel and iron pipe skelp as compiled by the American Iron and Steel Institute and published in Special Statistical Bulletin No. 3 (1916):

PRODUCTION OF IRON AND STEEL SKELP IN THE UNITED STATES FROM 1905 TO 1915. GROSS TONS

Year	Iron	Steel	Total	Per Cent Iron	Per Cent Steel
1905.....	452,797	983,198	1,435,995	31.5	68.5
1906.....	391,517	1,137,068	1,528,585	25.7	74.3
1907.....	444,536	1,358,091	1,802,627	24.6	75.4
1908.....	297,049	853,534	1,150,583	25.8	74.2
1909.....	370,151	1,663,230	2,033,381	18.2	81.8
1910.....	350,578	1,477,616	1,828,194	19.2	80.8
1911.....	322,397	1,658,276	1,980,673	16.3	83.7
1912.....	327,012	2,119,804	2,446,816	13.3	86.7
1913.....	312,746	2,189,218	2,501,964	12.5	87.5
1914.....	264,340	1,718,091	1,982,431	13.3	86.7
1915.....	262,198	2,037,266	2,299,464	11.4	88.6

Here is concrete evidence of the wide use of steel pipe. Occasionally one hears the statement that wrought iron pipe is "coming back," but certainly in the light of the above statistics this is quickly disproved.

Analysis of these statistics shows:

(*a*) The production of wrought iron skelp (from which the pipe is made) during the year 1915 is the lowest production in any year on record.

(*b*) Not only is the actual production lower but the percentage of wrought iron to the total skelp produced is the lowest on record, this being 11.4 percent.

(*c*) While the tonnage of wrought iron skelp manufactured was the lowest on record the steel skelp produced during 1915 was only exceeded by the production for the years 1912 and 1913. In the production of wrought iron skelp, beginning with 1912, each year has shown a decline from the record of the previous year.

Certainly these authentic statistics show the general trend of the times. Steel pipe has invaded practically every industry where pipe is required. Steel pipe is now recognized, not only as standard for oil and gas fields, but for water works, power plants, irrigation systems, railway systems, building construction, manufactories and hundreds—yes, thousands—of other fields. The mechanical uses for both welded and seamless steel tubing are without number. One can hardly turn around without seeing evidence of this on every side.

In fact, the demand has been so great for steel pipe that one of the largest manufacturers of wrought steel pipe has recently begun the erection of a new mill at Gary, Ind., which

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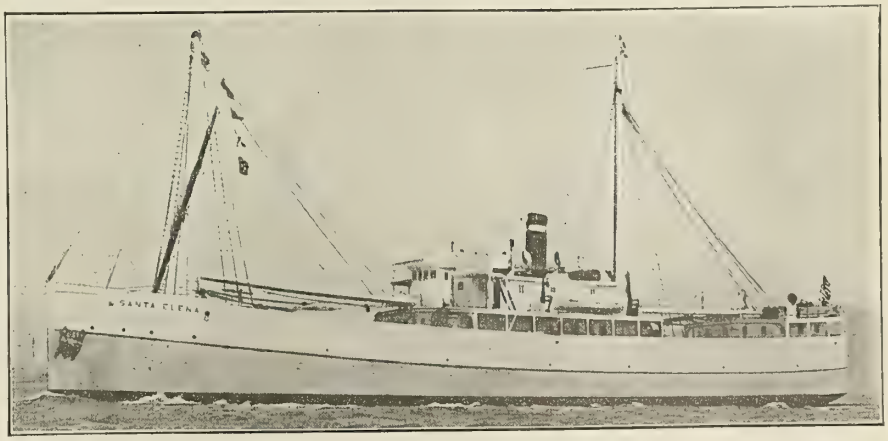
The Engine that is *NOT* a Diesel—The Engine that is *NOT* a Semi-Diesel--The Engine that is the Standard for Hot Bulb Engines

VESSELS NOW IN SERVICE OR BUILDING IN U. S. A. ALONE FITTED WITH BOLINDER ENGINES AGGREGATE 175,000 TONS D. W.



Motor ship "SANTA ELENA"—one of *five* owned by Messrs. W. R. Grace & Company of San Francisco, *each* fitted with 640 B. H. P. Bolinder.

BOLINDER'S COMPANY, 30 Church St., New York

will have a capacity of over 500,000 tons annually—probably more than the greatest tonnage of wrought iron pipe ever made in any single year.

But why should steel pipe find such universal use?

Why should the consumer, the engineer, the architect, the purchasing agent and all others who use or specify pipe, specify steel pipe?

Because the modern well-made steel pipe is strong and very ductile. Steel pipe has a tensile strength of 58,000 pounds per square inch—an elastic limit of 36,000 pounds per square inch —22 percent elongation in 8 inches and 55 percent reduction in area.

Because, in ductility, modern steel pipe excels any material heretofore used in the manufacture of wrought pipe, on account of the constant uniformity of chemical and physical properties. Steel pipe is made by machinery in very large unit quantities, under the personal supervision of a few highly trained men, which makes possible the maintenance of this unvarying uniformity. As a concrete example of the absolute control of the chemical composition of modern pipe steel suffice it to say that the carbon content does not vary .01 percent in a year's work. The carbon content is so low (not more than .14 percent in "National" Pipe) that steel pipe will not take a temper when heated to redness and quenched in water, and will bend without fracture through 180 degrees before and after quenching.

Well-made steel pipe is easily threaded, and gives good, strong, clean-cut and durable threads, which make tight joints —a most essential factor in any pipe installation. The power required to thread steel pipe is approximately the same as required to thread genuine wrought iron pipe.

Soft, mild steel pipe is uniform in physical structure. There are no blisters or laminations to contend with, for steel pipe is made from skelp rolled from the solid billet and not from a number of plates piled together, heated and rolled into skelp. Steel pipe gives a good, strong weld, and this, together with the great physical strength of the material, makes steel pipe safe for any installation requiring the use of wrought pipe. Steel pipe is "safety first" and "safety always."

After years of experience, study of service conditions, manufacturing processes and extended research work, steel pipe manufacturers have been able to continually improve their product wherever improvement has been possible. For many years steel pipe has been equally as durable as wrought iron pipe. To-day in many instances, steel pipe has been proved to be more durable. Modern steel pipe contains less than .5 percent of impurities—is practically pure iron. And in pure iron maximum durability is obtained. There is approximately 99.5 percent pure iron in steel pipe.

The opinion at one time advanced in certain sections that wrought iron pipe was more durable than steel pipe has long since disappeared. Hundreds of service investigations, by practical engineers, contractors, industries and many disinterested authorities on iron and steel products, of steel and iron pipe installed upwards of fifteen or twenty years ago, have proved that there is little or no difference in the durability of the two products. Practically all the investigations have been made in the field where both classes of pipe have been installed in identical service. Often, unknown to the owner, there have been accidentally installed alternate lengths of steel and iron pipe, especially during that period when there was a free mixture of both classes of pipe in many installations. These mixed installations have been of inestimable value to the investigator, because all service conditions were then identical and comparative results of service became invaluable.

The now acknowledged fact that wrought steel and wrought iron pipe are equally durable, however, does not prove that poorly made steel pipe is equal to the best grades of wrought iron pipe, or vice versa, for there are many indifferent grades of both classes of pipe on the market. The largest manufacturer in America of steel pipe was at one time the largest manufacturer of wourght iron pipe; but after many years of investigation and research work finally abandoned the manufacture of wrought iron pipe in favor of the modern steel pipe, being convinced that well-made wrought steel pipe is not only equal in durability but superior in physical properties to the best grades of wrought iron pipe made.

Steel pipe is the recognized leader of all wrought tubular products. Why? Because steel pipe has been awarded the Grand Prize by the Superior Jury of Awards at the Panama-Pacific Exposition, San Francisco, 1915.

Steel pipe represents progress.

The development and progress of the wrought pipe industry since the introduction of steel pipe has been apace with that of other engineering fields. A few years ago we drove a "coach and four"—to-day we are hardly content with a high-powered motor car. Yesterday we heralded the carbon filament as a

200 VESSELS
(NOW BUILDING)
WILL CARRY
PROPELLERS
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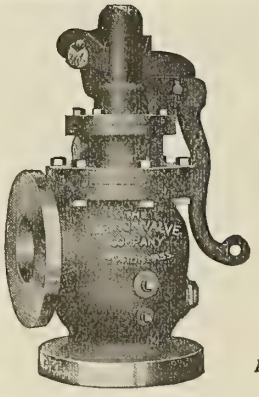
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All Sizes of Crane, Quarry, Railroad and Ship Chains, and Chain Hoists.

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Paint economy is not the price paid but the number of years of service given. Longest protection against storms, salt air, and other deleterious conditions is given by

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when used for all metal or wood work **not** under water.

It has been made in First Quality Only for over Fifty years.

Our Paint Department is prepared to advise promptly reagrding your paint problems.

Write for Booklet No. 75-B and advice.

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ESTABLISHED 1827

brilliant substitute for the gas light—to-day we have far surpassed its brilliancy with the nitrogen lamp. For centuries man said it was impossible to build a flying machine that would fly—but this has long since been accomplished.

Many of us can remember that we were glad to ride on the horse cars, but can we really compare our modern high-speed interurban electric to this primitive mode of travel? Could the modern farmer reap his thousands of acres of wheat with the old-fashioned scythe? To-day gigantic reaping machines make harvests almost a play-time. We all were willing to sit in the "bald-headed" row at the theater and pay top-notch prices until the advent of the "movie," where we can now see the same play for a dime!

We were all willing to use wrought iron pipe until the more modern steel pipe had proved itself. But to-day it is steel first and always. And why? Because steel pipe represents progress. Man is not content to stand still. He must progress. And this is true: steel pipe has kept apace with the advancement and progress of the times. The steel pipe of to-day is the best wrought pipe that has ever been manufactured.

Drawing tables, filing cabinets, instruments of precision, planimeters, pantographs, slide rules and other similar instruments, are described by F. Weber & Company, 1125 Chestnut street, Philadelphia, Pa., in a catalogue recently published.

"To Win the War!" is the title of a circular published by the L. S. Starrett Company, Athol, Mass., calling attention to the important use of hack saws in shipyards. "Every minute wasted in an American shipyard prolongs the war. Every minute a mechanic uses a hack saw should be productive, not wasted. Hack saws are important—they can waste much time. Some cut slowly because of poor quality, or because not suited to the job; then there's time lost by breakage. But Starrett hack saws cut quicker; last longer, because made of tungsten steel, with teeth milled right and tempered right. Every shipyard should see to it that Starrett saws are used, for Starrett hack saws are unexcelled, just as Starrett tools are unexcelled. To get the utmost from hack saws choose a Starrett of the right number. Our catalogue tells what number to pick for given shapes or metals. If you're not using Starrett hack saws send at once for the Starrett Catalogue No. 21-L."

Powell Grease Cups are the subject of a vestpocket-sized booklet just issued by the William Powell Company, Cincinnati, Ohio. "Powell grease cups are specially designed for the purpose indicated and recommended by competent users everywhere. In the following pages of this booklet you will find illustrations and descriptions of a complete line of automatic grease cups. We feel assured the trade will find exactly what they require and can adapt for their particular use. All parts of our cups are made very strong and durable, finished in workmanlike manner, tested and inspected rigidly before leaving the factory. Engineers and mechanics no longer waste time arguing over the relative merits of grease and oil for lubricating purposes. Grease, after all, is only oil in another form, just as ice is only another form of water. Grease is oil at its best. Good grease used in Powell Grease cups has solved the waste problem in lubrication. These cups have paved the way to the highest economy and efficiency. One filling can be so regulated to last a long time."

Heavy-Duty Diesel Type Marine Engines are described by the McIntosh & Seymour Corporation, Auburn, N. Y., in a catalogue just published. "These marine engines are the result of eighteen years' stationary and marine Diesel engine experience and thirty years' experience in building the largest and highest class of steam engines. These engines are built in the largest and most completely equipped plant in this country, which is devoted exclusively to the building of Diesel type oil engines. Shipowners and shipbuilders should avail themselves of these facilities, because full Diesel type motor ships can carry more cargo for a given displacement than a steamship, as the space required for the Diesel type oil engine and fuel is much less than that required by steam engines, condensers, boilers and the necessary coal bunkers. On account of the extremely low fuel consumption (about one-third of a pound per indicated horsepower) much less fuel is required by a motor ship. The oil fuel, which can be handled through pipes by a pump, can be stored in parts of the ship that are inaccessible for coal, and can be much more easily handled. Because of the extremely small fuel consumption, fuel enough can be carried for extremely long voyages. The elimination of the boilers and the handling of coal make a small crew possible, saving the space they require and their maintenance. All the above gives motor ships greater earning power. Sizes available: 300, 500, 750, 1,200 and 1,350 brake-horsepower. All six-cylinder, all four-cycle, and all directly reversible."

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from 70 to 80% without sacrificing reliability, flexibility or control. Perfect combustion on Kerosene or lowest grade of Coast Distillate.

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The gasoline question has been solved by the

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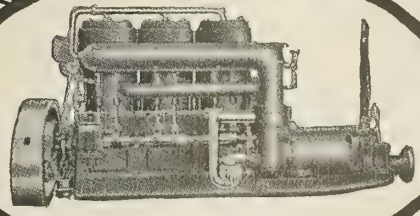

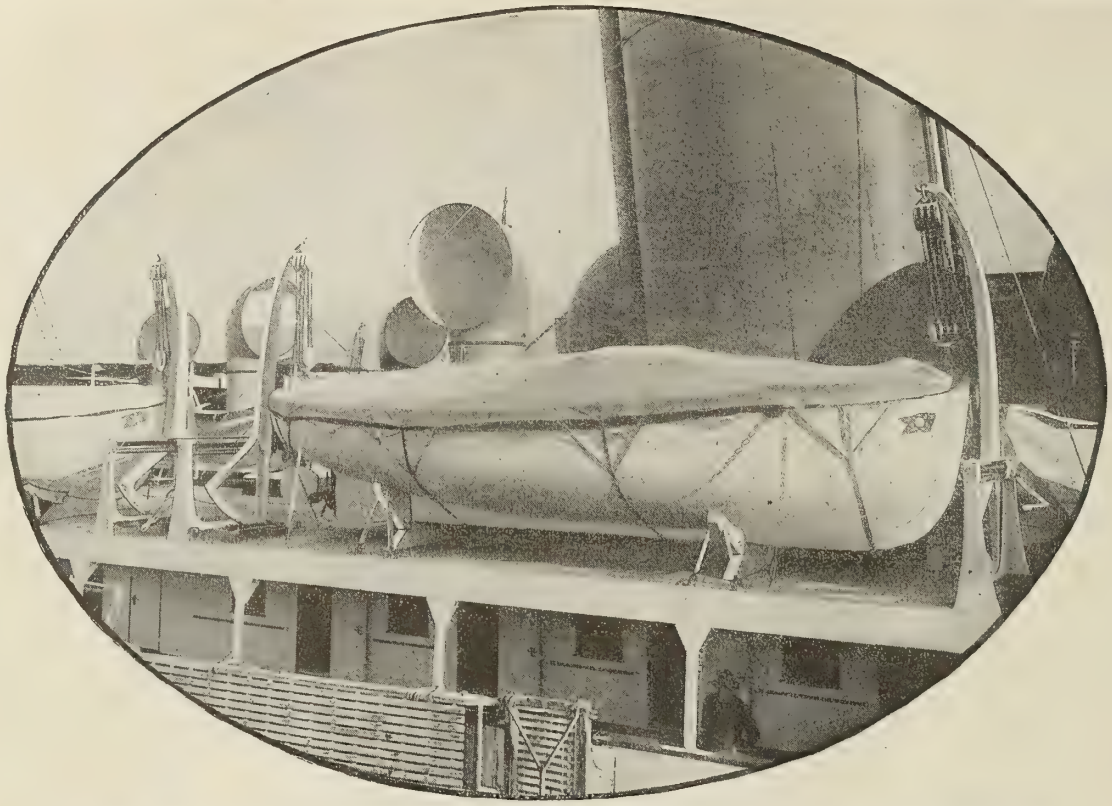

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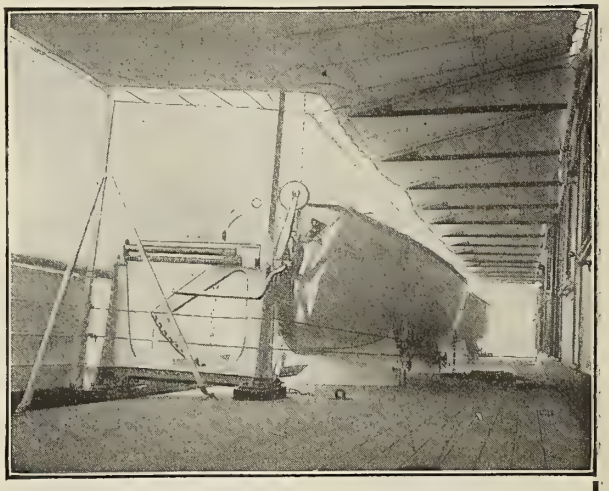
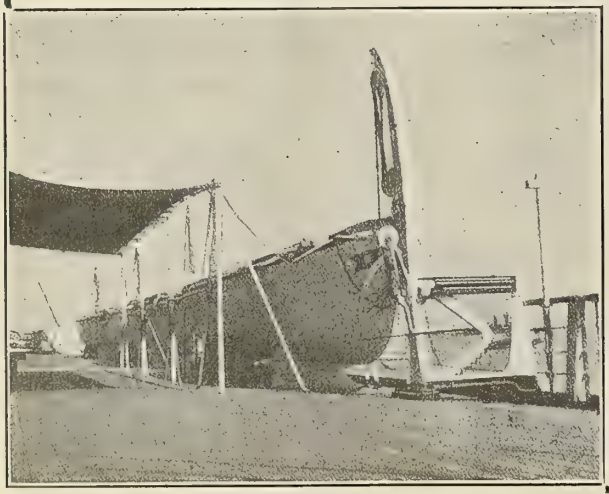
This ship is equipped throughout with Welin Quadrant Davits and our Standard Steel Keel Metallic Lifeboats and a wooden power lifeboat.

This equipment covers the requirements in accordance with the provisions of the International Conference on Safety of Life at Sea and the latest U. S. Inspection.

It provides life boat capacity for all on board, and insures the greatest efficiency and security in time of need.



Some of the nine 28 Ft. Steel Keel
50-Person Standard Metallic Life
Boats on the "Matsonia"



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- Pocket Compasses.
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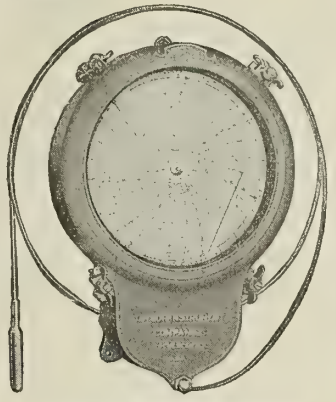
- Rain Gauges.
- Anemometers.
- Air Meters.
- Thermographs.
- Hand Levels.
- Aviation Barometers.
- Inclinometers.
- Sphygmomanometers.
- Fever Thermometers.
- Urinary Glassware.
- Thermometers of all kinds for home and general use.



Tycos RECORDING THERMOMETER
Dial Type Moisture-Proof Case

This instrument is especially fitted for plants where the atmospheric conditions necessitate the use of a case absolutely moisture, dust and fume proof.

Fully described in our catalogues which we will cheerfully send on request.

Taylor Instrument Companies
ROCHESTER, N. Y.

"Jeffery's Marine Glue vs. White Lead for Applying Canvas to Decks" is the title of one of the articles in the catalogue issued by L. W. Ferdinand & Company, 152 Kneeland street, Boston, Mass. "Marine glue is absolutely waterproof, and a deck painted with a heavy coat of hot glue must be waterproof even before the canvas is applied. The operation of laying the canvas in the glue by ironing it with a hot flatiron draws a portion of the glue up into the pores of the canvas, filling and waterproofing it, so that no water can soak into it or the wood beneath. In the case of white lead it is neither waterproof nor a filler, it may shed water for a time, but not a very long time. As a filler the best you can hope to do is to work it into the face of the canvas, it does not permeate it as with glue. The worst feature about lead, however, is the fact that the oil or the combination of the oil and lead rots the canvas in a short time, whereas with Marine Glue the canvas is waterproofed and preserved, neither water nor oil can permeate it and it will last as long as the boat. We recommend Jeffery's No. 7 Marine Glue, or Special Canoe Glue, for applying canvas to decks, tops of cabins and for covering canvas boats and canoes."

Saws for Cutting Metal are described by the Simonds Manufacturing Company, Fitchburg, Mass., in a bulletin just published. This company makes metal saws for any kind, size or style of machine, slitters, screw slotters, hack saws and files; also every style and size of wood-cutting saws. The bulletin goes on to state, "These are a few of our dependable steel products. What do *you* need in steel products?"

Vulcan Soot Cleaners are described and illustrated in a 92-page catalogue issued by the Vulcan Soot Cleaner Company, Du Bois, Pa. "The growth in the size of boilers, the great increase in combustion rates and loads, and the demand for higher efficiencies of heat absorption, have all resulted in a closer scrutiny of the variables affecting heat transfer through boiler tubes. It has been found that when the combustion rate and load are doubled with a corresponding increase in the velocity of the gases, and when the boiler surface is maintained clean of coatings of soot and deposits of ash, two times as much heat is absorbed by each square foot of surface, and the temperature of the waste gases is little or no higher than that of the gases formerly discharged from boilers operated at low loads, with sluggish flow of gases and coated, insulated tube surface. Summed up, the modern practice in steam plant design is to drive boilers at higher rates per unit of surface, and to keep the heating surface working at high efficiency by maintaining it clean. The Vulcan soot cleaner is not to be confused with scale removal appliances for the water side of the surface, or with 'soot blowers.' The Vulcan cleaner is a complete, permanent, mechanical cleaning system, comprising standardized elements, which are arranged to form different designs according to the type of boiler and conditions to be met."

The I. O. C. System of "Bipolar" oxygen and hydrogen generating sets is described in an illustrated 24-page catalogue published by the International Oxygen Company, 115 Broadway, New York. "The industrial applications of oxygen and hydrogen—numerous and diverse and important as they are—have from the first been limited by the means available for the generation of these gases on a commercially economical scale. Though the advantages of these applications have long been known theoretically, their practical adoption in the mechanical arts has increased only as the means of gas generation have advanced toward higher commercial efficiency. In presenting its bipolar oxygen and hydrogen generator, this company feels that a forward step has been taken which will lead to even more general use of oxygen and hydrogen in the industrial world. And the new machine is recommended on these grounds to both present and prospective users of oxygen and hydrogen in quantities. This company was the first to introduce oxygen and hydrogen generating equipment in America on a commercial scale. And the soundness of its methods and the high quality of its product are attested by the fact that the I. O. C. unit or cell type generator is to-day generally recognized as the standard of efficiency and economy in the commercial production of oxygen and hydrogen. Without in any way disparaging or discrediting its unit type generator, the company offers its bipolar generators as a new and proved device, affording, for certain operating conditions, distinct advantages over the earlier model—which, by the way, will continue to be manufactured and improved to meet its special field. The I. O. C. bipolar generator is the result of several years' development of a method of electrolytic gas production embodied in a French patent. The type has passed through several progressive stages in the seeking for more perfect results. And in its present form the new generator is offered, not as an experiment, but as a tested apparatus that is mechanically, electrically, chemically and commercially right."

REG'D TRADE MARK

INTERNATIONAL
COMPOSITIONS FOR IRON AND STEEL VESSELS' BOTTOMS
In use and in stock at all ports of the world. Over 18,000,000 gross tons of shipping coated annually
Proprietors of INTERNATIONAL COMPOSITION, ANTICORROSIVE, and ANTIFOULING
INTERNATIONAL COMPOSITIONS CO. Offices, Welles Bldg., 18 Broadway, N. Y.

STRATFORD OAKUM
QUALITY GUARANTEED JERSEY CITY and EVERYWHERE
GEO. STRATFORD OAKUM CO. - - - - - 165 CORNELISON AVE., JERSEY CITY, U. S. A.

Quality *Service*

SUN OILS

Reliability *Efficiency*

SUN MARINE OILS

HAVE PROVED THEIR WORTH

Give your ships a chance by supplying only the best oils obtainable.

SUN COMPANY

1428 SOUTH PENN SQUARE, PHILADELPHIA, PA.

Stocks carried at

New York City, Boston, Philadelphia, Baltimore, Pittsburgh, Cincinnati, Buffalo, St. Louis, Chicago, Minneapolis, Toledo, Newark, Newport News, Detroit, Atlanta, New Orleans, Sabine

UNION DRY DOCK & REPAIR CO.
Vessel Repairs in Wood and Iron
WEEHAWKEN, N. J.
Dry Docks and Shipyard Adjoining West Shore Ferry
TELEPHONE, 904-905 UNION

SEND FOR NEW BOOKLET
"Marine Glue—What to Use and How to Use It"
We would esteem it a privilege to answer any question that may arise in regard to this material.
L. W. FERDINAND & CO.
152 KNEELAND STREET BOSTON, MASS., U. S. A.

The Invincible Nozzle
Fire Department Supplies
ANDREW J. MORSE & SON
INCORPORATED
221 HIGH ST., BOSTON, MASS.
DIVING APPARATUS

The Coburn Overhead Carrying System is described in a profusely illustrated catalogue of 56 pages, published by the Coburn Trolley Track Manufacturing Company, Holyoke, Mass. "The great cost of any business is waste. Any waste is bad enough, but time is the greatest waste of all. It is impossible to calculate what lost time might have produced. Time is a ruling factor—competition is keen. Are you as well equipped to produce as your competitor, or does he slip in just ahead and win out? Are you aiding your production forces by adopting proven methods to minimize the labor involved in handling your products during the process of manufacture?"

For the Protection of Shipyards.—The importance of keeping out trespassers is recognized by shipbuilders and factory owners all over the country—and especially so under present conditions. The Anchor Post Iron Works, 25 Cortland street, South, New York, have published a bulletin describing their Anchor Post Fences. "Every American shipbuilder recognizes the vital importance of keeping trespassers off of his property. Not every shipbuilder, however, is aware of the almost absolute protection against thieves, tramps and even more dangerously malicious trespassers, that is provided by an unclimbable 'Anchor Post' chain link woven steel fence. These fences have been protecting factory properties all over the country for many years. We have yet to hear of a single one that has not afforded the high degree of security claimed for it. Made of heavy interlinking rods of No. 6 steel wire, and supported by high-carbon steel U-bar posts of generous section and weight, Anchor Post factory fences have such a long period of life that the first fence of this type (erected over ten years ago) is still in as serviceable condition as the day it was put up. Anchor Post fences have been approved and adopted by the engineers of the United States Navy and War Departments, and are used by hundreds of industrial corporations for the protection of their workmen and their plants. Our catalogue and the service of our engineers are at your immediate command. A line from you will bring prompt action.

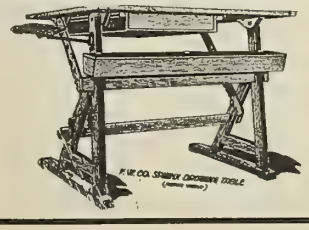
The Turner Baffle Wall is the subject of a circular published by The Engineering Company, 17 Battery Place, New York. "Leaky boiler baffles need not be a necessary evil, and you do not have to stand the loss that comes from missing tile or burned flame plates. The Turner baffle wall is built tight and stays tight. It is structurally correct. Firebrick are laid through the tubes to form diagonal shelves, and the pockets between the tubes and the brick are completely filled with a fire-resisting cement in a plastic condition. This construction gives a wall that will resist the intense heat of modern boiler room practice and provides for the easy renewal of tubes without injury. The replacement of destroyed flame plates is unnecessary, and the wall can be built at any angle to give the best form of tapered pass when bridge walls are moved back of the stokers or the settings remodeled. Turner walls built four years ago are still sound and tight. We contract for baffles in place."

BUSINESS NOTES

THE MCITOSH & SEYMOUR CORPORATION, Auburn N. Y,, announces that on account of the present unusual demand for marine equipment, it has transferred Mr. C. G. Cox, the company's present Central District manager, to the Pacific Coast, and has temporarily closed the St. Louis office. Mr. Cox will make his headquarters in San Francisco and Portland.

BOILER MANUFACTURERS' WAR SERVICE COMMITTEE.—Conforming to resolution adopted at the meeting of manufacturers with the National Chamber of Commerce, requesting all lines of business to appoint a war service committee to act as "point of contact" between said industry and the United States Government during the period of the war, the American Boiler Manufacturers' Association has appointed their committee as follows: George W .Bach, manager, Union Iron Works, Erie, Pa.; G. S. Barnum, president, Bigelow Company, New Haven, Conn.; W. C. Connelly, president, The D. Connelly Boiler Company, Cleveland, Ohio, chairman. Any one having business pertaining to boilers should address the chairman at once.

MEN WANTED FOR CIVILIAN EMPLOYMENTS IN THE ARMY.—The Quartermaster Enlisted Reserve Corps, with recruiting headquarters at 357 Broadway, New York City, have received a new authorization to enlist men to follow their civilian occupations in the army for duty in this country and abroad. The men particularly needed at this time are electricians, tinsmiths, iron workers, carpenters, plumbers, mechanics (auto.), mechanics (general), masons, bricklayers, farriers, horseshoers, saddlers, blacksmiths, teamsters, cooks, chauffeurs, stenographers, wagonmasters. Enlistment is open to citizens of the United States, or to those men who have declared their intentions of becoming citizens. They must be between the ages of 18-45 years, and have no one depending on them for support. Men who can qualify for the above positions will be examined physically at recruiting headquarters, 357 Broadway, New York City, and immediately sworn into service, and will be given a week or more time in which to arrange their private affairs before being called for active service. The enlistment in the Quartermaster Corps is for qualified men, and military training as a soldier is not required in this branch of the service. They do not have to drill with rifles, perform guard duty or other purely military duties which fall to the lot of soldiers of the infantry, cavalry and other branches of the army, except in cases of emergency. You can be enlisted up to the time your notice to appear for physical examination is posted by your local board. Applicants will be received at the Quartermaster Corps recruiting station at 357 Broadway,



Manufacturers and Importers
Drawing Tables, Filing Cabinets, Instruments of Precision, Drawing Materials, Planimeters, Pantographs, Slide Rules
F. WEBER & COMPANY
1125 Chestuut Street **Philadelphia, Pa.**
Branches: St. Louis and Baltimore

Abnormal Business Conditions—
What We Are Doing To Meet Them—

Chapter B

Increasing Our Cylinder Equipment—At The Rate Of One Car Load Per Day

Since April 1915—

We have contracted for the maximum number of new cylinders possible to obtain from American manufacturers.

These contracts cover the output of these manufacturers up to August 1918—which means an extension of the Linde Service that will represent an investment of several million dollars.

This rapid development of our cylinder equipment—to transport the Oxygen shipped from 64 Distributing Stations, will not only enable us to relieve the abnormal demand-troubles in every direction, but will make the **Linde Company practically the one source of supply** for users of Oxygen whose requirements demand insurance of regular deliveries, regardless of general or local conditions.

Copy C, the next of this series of advertisements, will tell how we have, in our efforts to maintain **Linde Service,** re-shipped cylinders from as many as four and five plants, to meet abnormal conditions at one plant.

The Linde Air Products Company

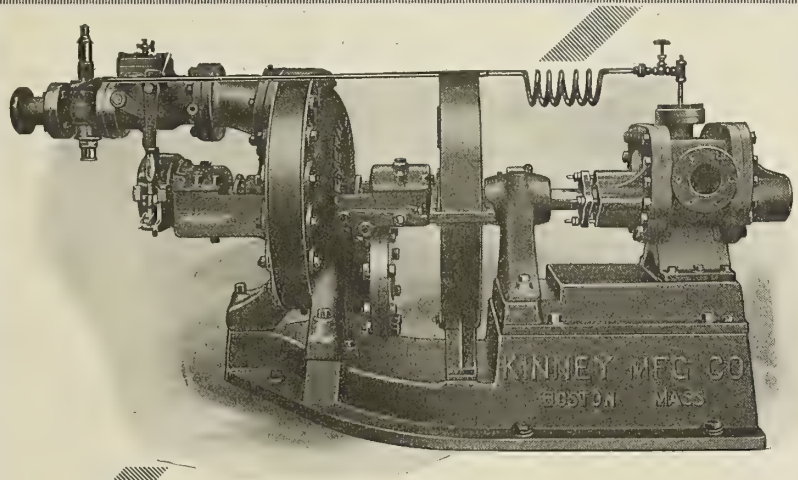
42nd Street Building, New York City, N. Y.

"Largest Producers of Oxygen in the World"

How Do You Figure?—Do you divide the years of service into the cost of paint, plus the cost of labor? If so, you have the correct method of figuring the yearly cost of paint protection. If you have metal surfaces or any exposed surfaces, whether of metal or wood, to repaint, it will be worth your while to purchase Dixon's Silica-Graphite Paint, because the longer service and better quality of Dixon's paint are worth a great deal more than a few cents per gallon. The careful and cautious user of paint will appreciate this fact. For over fifty years the slogan and standard of the Dixon Company in the matter of paint has been "the best and one grade only." If any one is looking for a low-priced paint and does not care about quality and long service, the Dixon Company has nothing for him; but if he desires quality and long service Dixon's Silica-Graphite Paint is the best for him. We are ready at all times to give detailed information, price and assistance in any way. Please write the Joseph Dixon Crucible Company, Jersey City, N. J., and watch Dixon's house organ, *Graphite*, for long service records.

"The Progress of the Screw Propeller."—Raymond E. Lovekin, managing director of the American Screw Propeller Company, Hale building, Philadelphia, Pa., writes Marine Engineering as follows: Ever since the early days when the naked hand of man was used as a paddle for the purpose of propelling a ship, there have been numerous experiments made in connection with securing the most efficient means to impart motion to a vessel. Probably the first rotary motion applied for this purpose was in the year 1472 or thereabouts, when numerous paddle-wheels were fitted along each side of a ship and rotated by man power from cranks connecting in the middle of the vessel. Numerous other experiments were made by inventors during the 15th and 16th centuries in connection with various types and shapes of paddle-wheels, also hydraulic propulsion, although experiments upon the latter never proved of any real value. In 1793 a paddle-boat operated by a steam engine was actually run from Manchester to Runcorn, but the speed obtained resulted in the abandonment of this vessel for the time, and it was nine years later that a stern paddle-boat actuated by a steam engine was quite successfully run in England. In 1807 Robert Fulton, of New York, U. S. A., produced the *Clermont*, which was a side-wheeler operated by a steam engine. This vessel proved quite successful and led Mr. Fulton to build several more quite efficient ships of practically the same type. From 1807 to 1875 many more or less successful attempts were made to utilize a screw propeller as a means of propulsion, special credit during this period of time being given to the following gentlemen: Willliam Church, John Millington, Jacob Perkins, Bennet Woodcroft, Samuel Brown, John Ericsson, Joseph Maudslay, Robert Griffiths, Sir John Thornycroft and Mr. Yarrow. It might also be interesting to note that during this time, in the year 1845, the first screw steamer, *Great Britain*, crossed the Atlantic. The development of the screw propeller from 1875 to the present date has been marvelous, so that to-day practically all self-propelled vessels (excepting some ferryboats and river steamers) are put in motion by means of a screw propeller. This fact is due to the numerous experiments made upon the resistances of hulls and the adoption of a model tank, also through investigations into the elements of screw propellers and their design. Probably the most credit during this time is due to the following gentlemen, whose untiring efforts and remarkable foresight has enabled them to be recognized the world over as experts; to these men is due the high credit which they so richly deserve: Professor Rankine, Mr. Sidney Barnaby, Mr. A. E. Seaton, Mr. Peabody, Mr. R. E. Froude, Rear Admiral David W. Taylor and Capt. C. W. Dyson. The latter two gentlemen, of whom the United States may well be proud, are undoubtedly recognized as the most modern authorities to-day in their professions; Admiral Taylor for his work in connection with the resistances of hulls and investigations of propulsive problems, and Capt. Dyson for his work in connection with the estimation of power for the propulsion of vessels and the standard method of propeller designing which he has evolved.

Industrial unrest, particularly apparent throughout the country at present, has long been intensively studied by executives and Government officials. The universal verdict seems to be that employees, as a whole, feel that the ideas of scientific management have been wholly wrong, and that far greater consideration must be given the human element. Increased wage scales and shorter working hours, which was hoped would solve the problem, have utterly failed; various welfare movements, formed to remove the cause of and waylay discord, have been only partially successful; private associations establishing systems of furnishing information



NO MORE TROUBLE WITH *YOUR* OIL BURNING EQUIPMENT

Up to the present, difficulty has been experienced with oil burning on shipboard due to the uneven flow of oil to the burners. This condition was caused by the impulses created by plunger pumps and often resulted in damaged baffle plates and other brick work in the furnaces.

THE KINNEY ROTATING PLUNGER PUMP

positively eliminates this trouble by supplying a smooth, continuous and uniform flow of oil to the burners.

If it's good enough for Uncle Sam, YOU should be interested.

SEND FOR CATALOGUE.

THE KINNEY MFG. CO.

BOSTON MASS.

of more or less accuracy to employers for their use in eliminating misunderstandings, have failed because of the lack of knowledge and inexperience of operators. Certain detective agencies have established systems of "strike breaking," employing men in the place of strikers to keep plants in operation. Naturally these men have usually been inefficient and often strong-arm methods were used, resulting in bloodshed and further misunderstandings. This method is impractical, expensive and costs industry millions of dollars a year. About ten years ago, John F. Sherman, after making a life study of industrial conditions, founded an institution to put into practice his own methods obtained through practical experience. He made industrial conciliation an exact science. The basic principle of "Sherman Service," which has served hundreds of leading corporations, is harmony. In reply to many requests. Mr. Sherman has had prepared an 80-page book explaining the successful methods which he employs in eliminating discord and promoting harmony between employer and employee. It contains many features valuable to executives at this time. The main offices of the "Sherman Service," at 20 Broad street, New York; 208 South La Salle street, Chicago, Ill.; 10 State street, Boston, and 42 Church street, New Haven, Conn., are sending out this book to executives only who request it on their corporation's letterhead.

MARINE REFRIGERATION.—Some of the sales made by the Brunswick Refrigerating Company for steamship work since the last report in this paper are as follows: Sun Shipbuilding Company, 2-ton plants for Hulls 17, 18, 19, 20. With this order the company now has orders for plants on ships from 1 to 20, inclusive. Hull 1, the *Chester Sun,* was recently launched.

Pacific American Fisheries, eight 1-ton plants for ships building by them. This is in addition to orders previously reported as sold to this company.

Bethlehem Steel Company, Maryland Shipbuilding Plant, a 1-ton plant for their Hull 176.

Clyde Steamship Company, 1-ton refrigerating plant for the S. S. *Sioux.* Refrigerator of two compartments is cooled, and drinking water cooled in a scuttle butt is circulated to several points in the ship.

Baltimore Dry Docks & Ship Building Co., 1-ton plants for their Hulls 83, 84, 88, 89, 91, 92.

Kerr Navigation Company, 2-ton plant for the S. S. *Kermanshah.*

Staten Island Shipbuilding Company, a 1-ton plant for their Hull 689.

Standard Shipbuilding Company, 1-ton plant for the S. S. *Scandinavic.*

U. S. Shipping Board in New York, 2-ton plant for the S. S. *Nassovia,* a 4-ton plant for the S. S. *Prinz Osker,* a 4-ton plant for the *Arcadia,* and a 4-ton plant for the *Rhaetia.*

Newport News Shipbuilding & Dry Dock Company, 2-ton plants for the S. S. *El Oriente* and the *El Sol.*

Manitowoc Shipbulding Company, a 1-ton plant for Hull 81.

Kerr Navigation Company, 2-ton plant for the S. S. *Kerrwood.*

F. B. Lindemann, a 1-ton plant for the S. S. *Rosalie Mahoney.*

R. L. Smith, Inc., 2-ton plant for the S. S. *Armenia,* replacing a machine of another make.

Capt. J. R. De Lamar, a ½-ton plant for the steam yacht *Savarona.*

Standard Oil Company of New Jersey, 2-ton plant for the S. S. *Standard.*

Newport News Shipbuilding & Dry Dock Company, 1-ton plants for the S. S. *Mariana* and the *Edward Peirce.* These are additional plants put aboard these ships on account of increasing the size of the refrigerator.

Clyde Steamship Company, a 1-ton plant for the S. S. *Choctow.*

James Shewan & Sons, a 2-ton plant for the S. S. *Westvego.*

To the Captain of S. S. *Freshwater,* a 1-ton plant.

To the Government, a 2-ton plant, making a duplicate unit on the S. S. *Orion.*

To the Kensington Shipyard, a 1-ton plant for the S. S. *Mundale.*

U. S. States Shipping Board in New York, a 1-ton plant, making a duplicate unit on board the S. S. *Scandinavic,* due to increasing the size of refrigerators.

The Brunswick Refrigerating Company report that they have machines in stock at all times and can make prompt shipment and installation; in fact, installations complete have been made in less than 60 hours from the time the order was given. Their marine booklet, "Dividends from Waste," and Bulletin No. 101, describing the machinery, will be sent gladly to any one interested applying to their Marine Department, at New Brunswick, N. J.

AGENCY WANTED

to represent some first-class engineering concerns on the Atlantic Coast, by trained and experienced engineer of high standing.

Address "AGENCY,"

Care of Marine Engineering

461 Eight Avenue, New York

Boiler Shop For Sale

Old established boiler plant, with national reputation, modern equipment for construction of largest sizes, marine boilers; in active operation; profits in present contracts will pay for plant, will inventory fifty percent on sale price. Desire to retire reason for sale. Full opportunity for investigation to inquirers with satisfactory references. Cash only.

Address Box 1000, care of MARINE ENGINEERING.

FOR SALE

Two (2) Southwark-Harris Valveless Oil Engines (Diesel Principle) 250 B.H.P., each, 200 R.P.M., Normal Speed, complete with wheels and accessories as listed and described hereinafter but without reversing attachment.

These engines are of the reversing Marine type and the reversing attachment can be supplied and attached by the Southwark Foundry & Machine Company at a reasonable cost.

ENGINE ACCESSORIES.

One (1) 5″ x 5″ American Blower Co. Vertical, self-oiling steam eng ne.

One (1) 4¼ x 6″ Southwark-Harris High Pressure Compressor.

One (1) 3 K.W. 125 volt Generator (Northwestern Mfg. Co., Milwaukee, Wis.)

Two (2) 70 gallon fuel oil service tank.

One (1) Marsh pump, 4″ steam end, 2¾″ water end, 3″ stroke.

One (1) Marsh pump, 4″ steam end, 3″ water end, 4″ stroke.

One (1) Marsh pump, 3″ steam end, 2½″ water end, 6½″ stroke.

One (1) H.P. Winslow Flash Type Boiler, (W.N. Best, New York City).

Two (2) 10,000 Gallon Storage Tanks.

All connection and necessary exhaust piping and all interconnecting piping and valves between engines, bottles, service tanks, lubricating system and compressor.

The approximate weights of each engine are 80,000 lbs.

Address "ENGINES FOR SALE"

Care of Marine Engineering

HELP AND SITUATION AND FOR SALE

☞ *No advertisement accepted unless cash accompanies the order.*

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Shipbuilder, sixteen years' experience, office and yard, college education, is open for responsible connection. Address *Box X,* care of MARINE ENGINEERING.

Leading two-cycle semi-Diesel engine manufacturer has territory open for live agents. Address *Semi-Diesel,* care of MARINE ENGINEERING.

Chief Draftsman, graduated naval architect, age 30, first-class man on Isherwood system and standard freighters, desires suitable connection. Address *Hull Draftsman,* care of MARINE ENGINEERING.

Practical organizer and accountant with wide experience in large contracting, lumber, shipbuilding and Government work, seeks connection. Address *Organizer,* care of MARINE ENGINEERING.

Draftsman Seeks Position.—Educated in the best schools of Europe, in architecture, and has had many years of experience in the highest grade of drafting work. Address *Drafting Work,* care of MARINE ENGINEERING.

Experienced engineer offers his services for the designing and supervision of shipyard construction ways, sheds, shops, crane supports and wharves. Address *Shipyard Construction,* care of MARINE ENGINEERING.

Turbine Engineer, graduate of Massachusetts Institute of Technology, with six years' executive experience in large Eastern manufacturing concern, in the development, design and testing of steam turbines, desires position as engineer in charge of turbine work in shipbuilding plant. Address *Turbine,* care of MARINE ENGINEERING.

Wanted—Supervisory position in shipbuilding plant. Twelve years' machine shop experience and twelve years' naval engineering service with reciprocating and turbine engines. Marked executive ability. References furnished. Address *Experienced,* care of MARINE ENGINEERING.

Wanted for the tropics, an experienced marine foreman for a large ship yard operating its own drydock. The applicant must be a man of experience capable of estimating repair and construction work and also handling said repairs. A Knowledge of Spanish is necessary. Address *Marine Foreman,* care of MARINE ENGINEERING.

Wanted for Shipbuilding Department, State Trade School, Bridgeport, Conn., hull draftsman. Mold loft and shipfitting experience required. Excellent opportunity for first-class man. Address *Connecticut State Board of Education,* Trade Instruction Department, Room 42, State Capitol, Hartford, Conn.

Executive Mechanical Engineer, 41, American, 20 years' practical experience as designer, chief engineer, general manager and consulting engineer, thoroughly conversant with all details of shipbuilding and shipyard construction for medium-size steel and wooden steamers; machine and foundry business, steam engines, boilers and auxiliaries. drydocking and repairs, desires change, preferably with new company, on government contracts, ships, engines or special machinery. Address *Executive,* care of MARINE ENGINEERING.

Experienced man desires position as manager of a saw mill, superintendent of construction work or superintendent of floating equipment. Any of these positions to be in connection with a shipyard logging its own mill by water or operating its own saw mill. Has made a specialty of superintending inland transportation in bulk, and has also had experience in building and maintaining Western river boats; as a manager of a saw mill, and as a steamboat pilot. Address *Construction Work,* care of MARINE ENGINEERING

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

AMERICAN ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

THE AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—G. W. Nusbaum, Navy Department, Washington, D. C.
Vice-President—Alfred H. Haag, Boulevard, Hampton, Va.
Secretary—B. G. Barnes, 40 Faxon Ave., Quincy, Mass.
Treasurer—P. K. Thurston, Navy Department, Washington, D. C.

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NATIONAL OFFICERS.
National President—Wm. S. Brown 996 Ellicot Square Bldg., Buffalo, N. Y.
National Secretary—Geo. A. Grubb, 1040 Dakin St., Chicago.
National Treasurer—Albert L. Jones, 38 Avery Ave., Detroit, Mich.

CANADA.

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—A. R. Milne, Kingston, Ont.
Grand Vice-President—E. J. Belanger, Bienville, Levis.
Grand Secretary-Treasurer—Neil J. Morrison, P. O. Box 886, St John, N. B.
Grand Conductor—J. W. McLeod, Owen Sound, Ont.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

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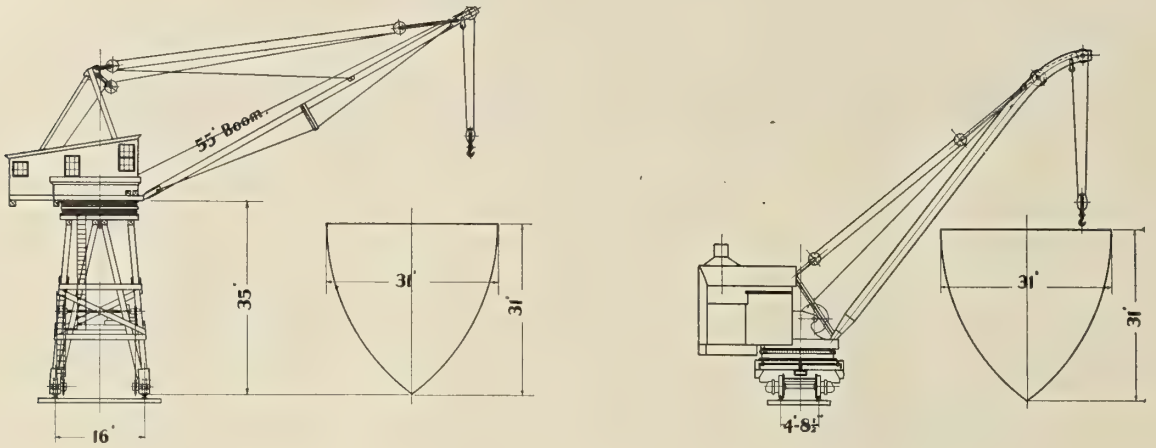

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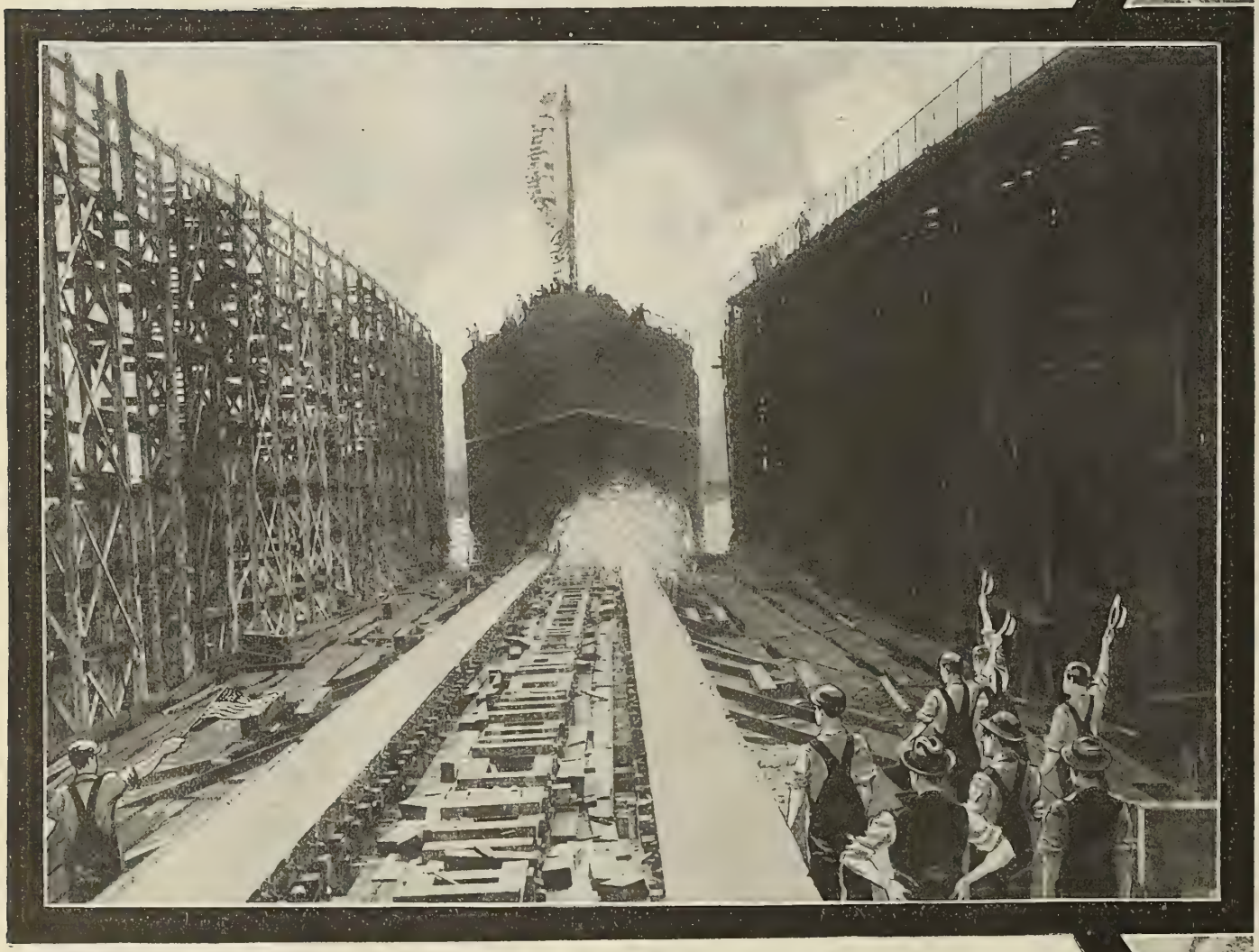

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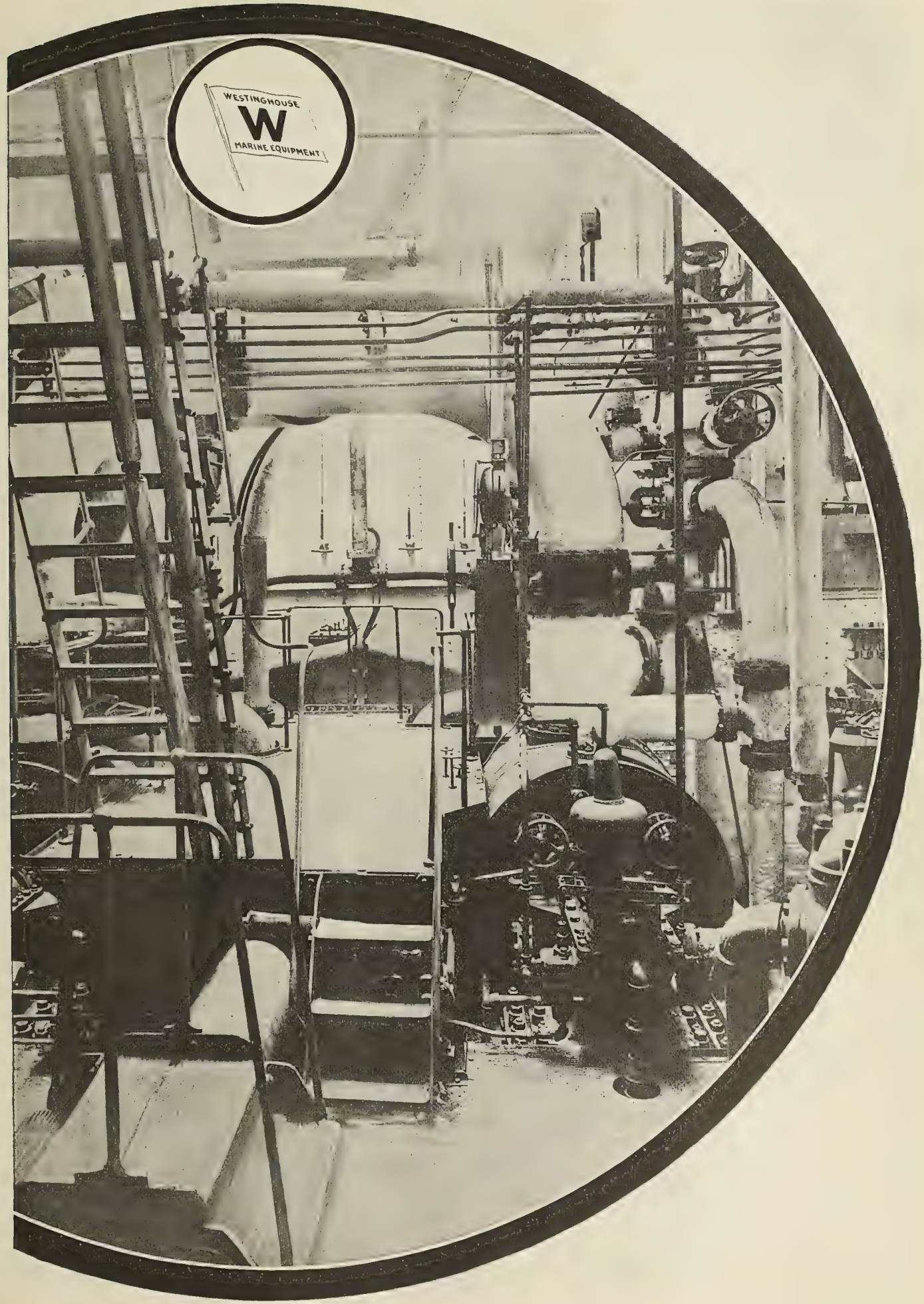

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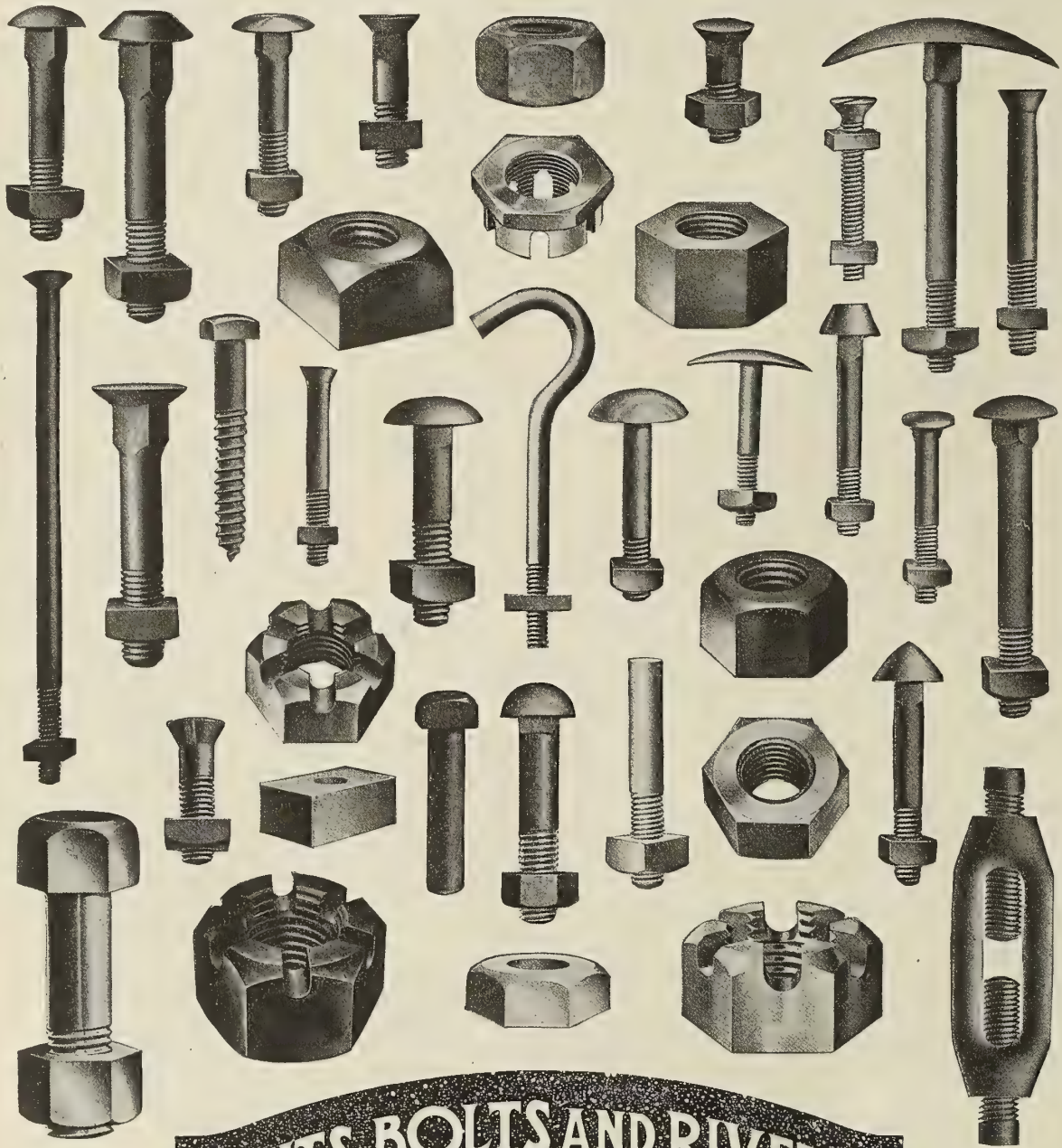

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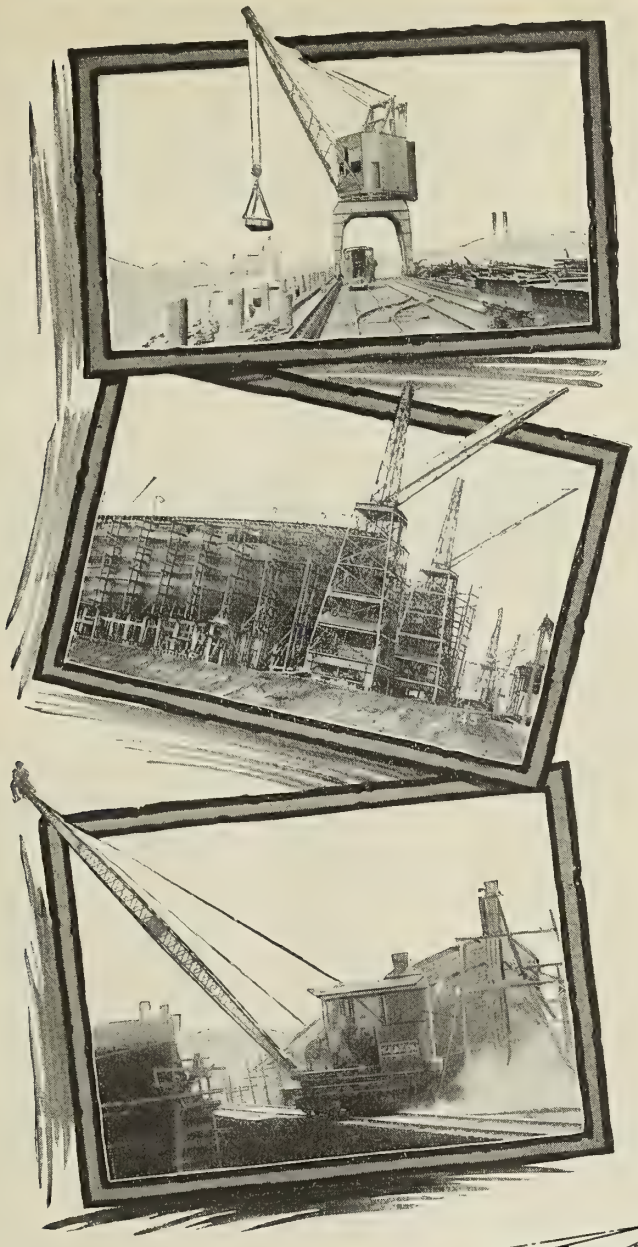

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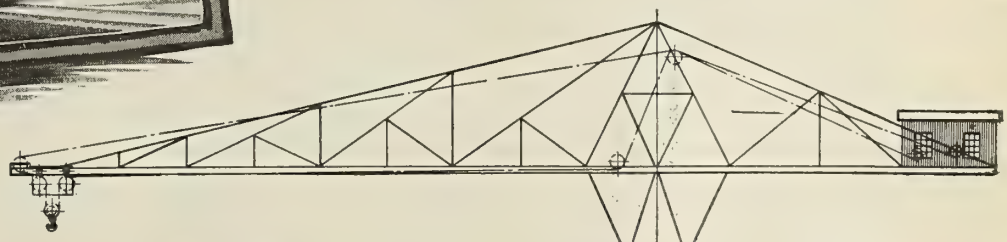

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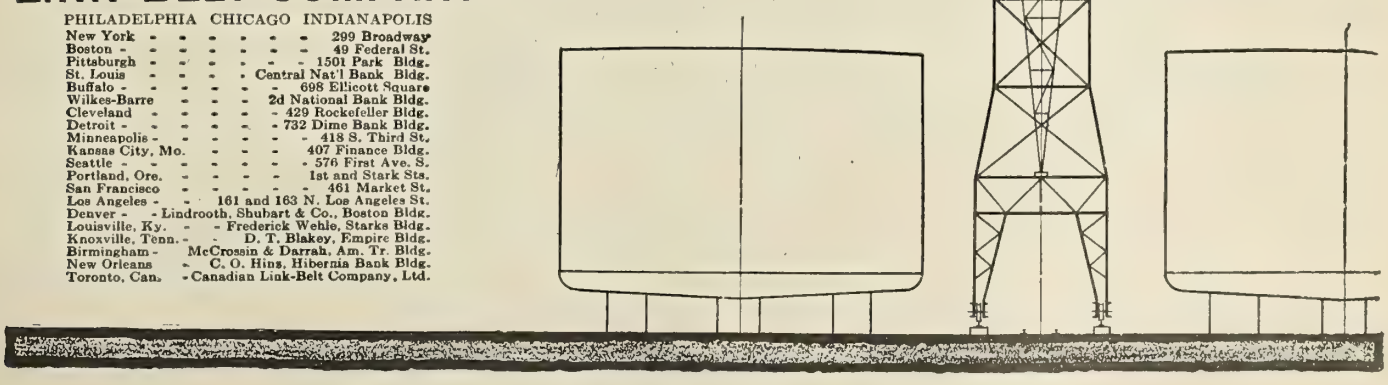

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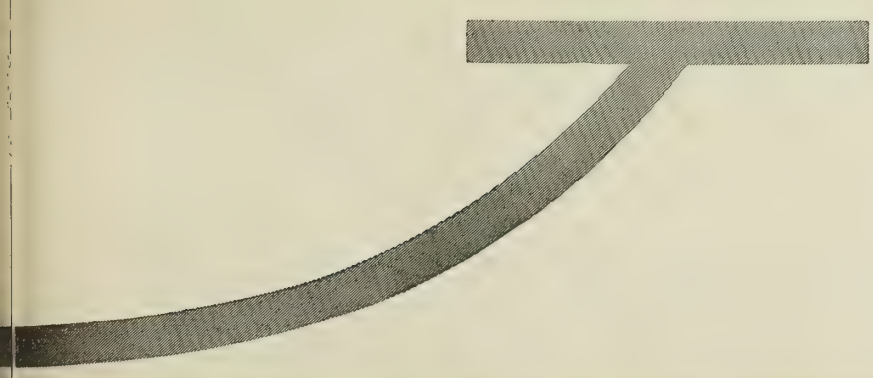

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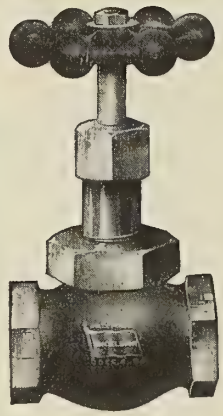

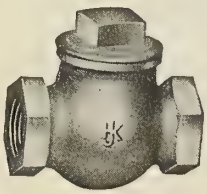
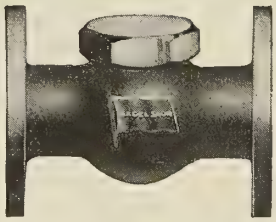

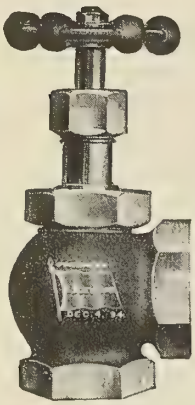
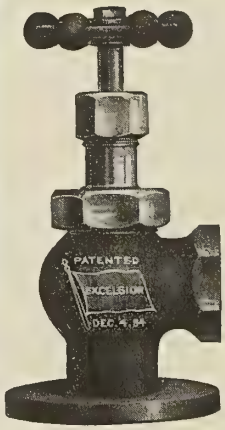
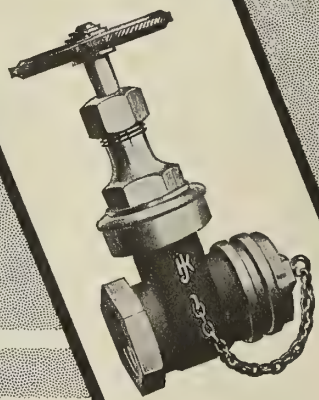

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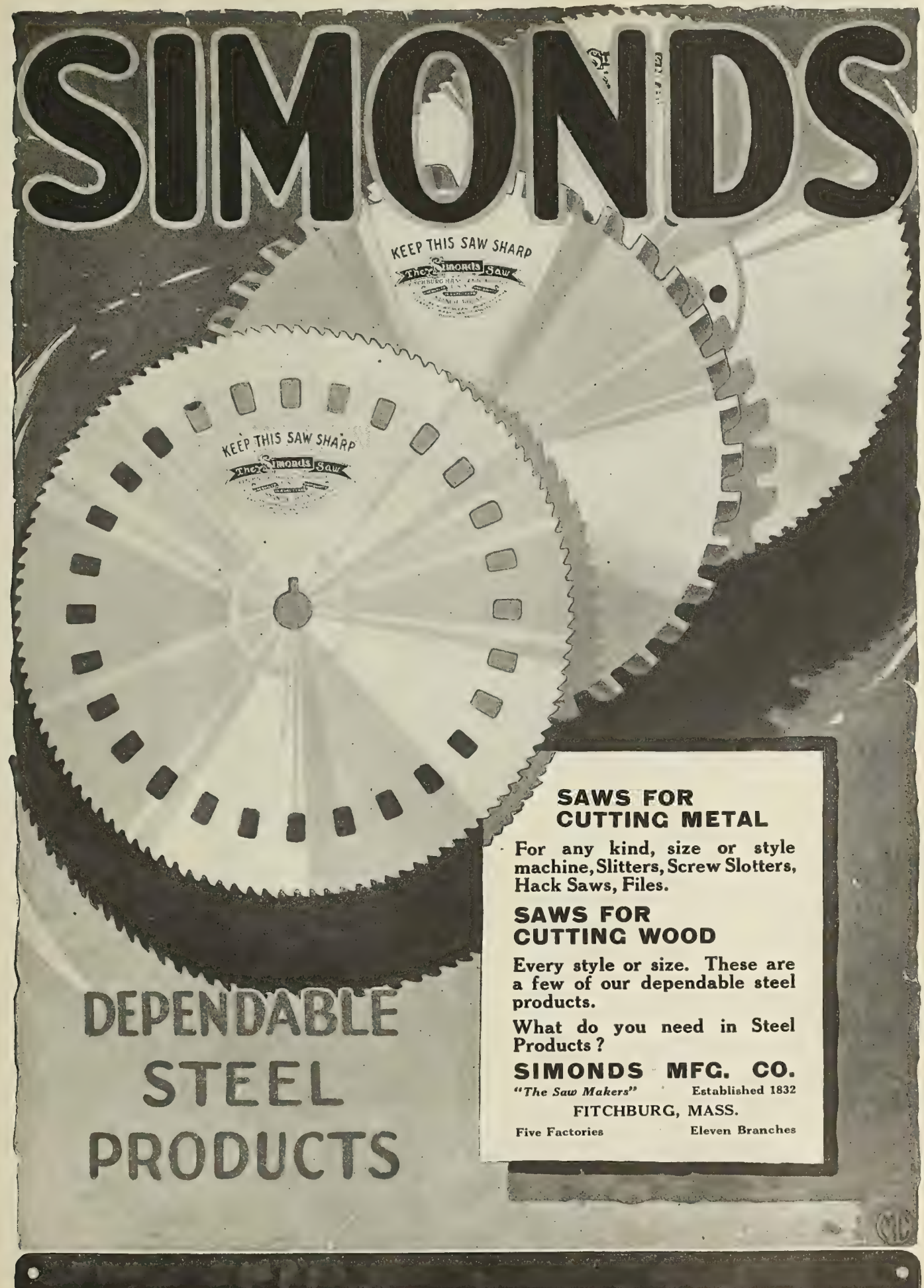
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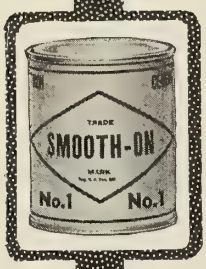

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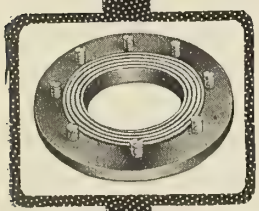

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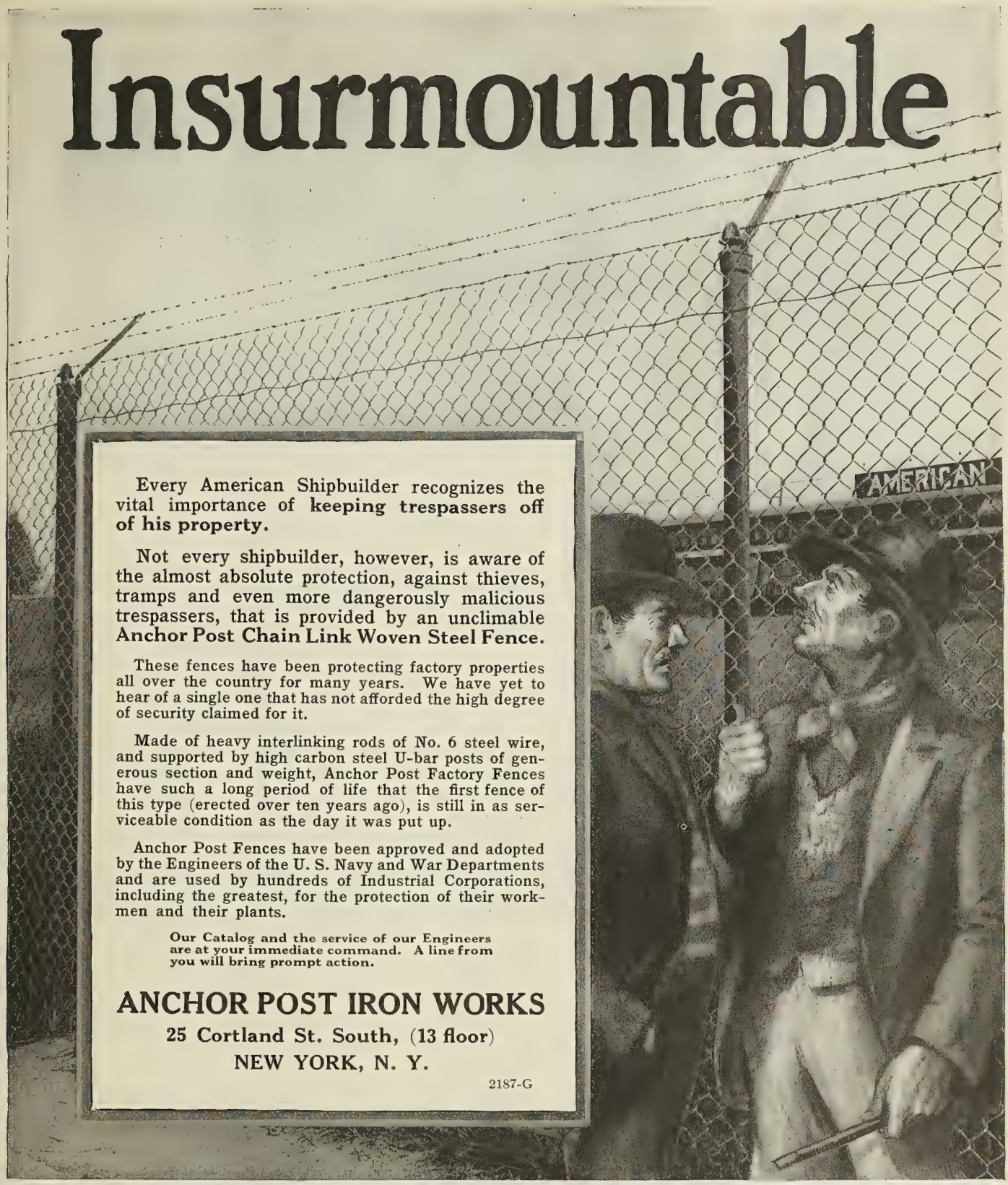

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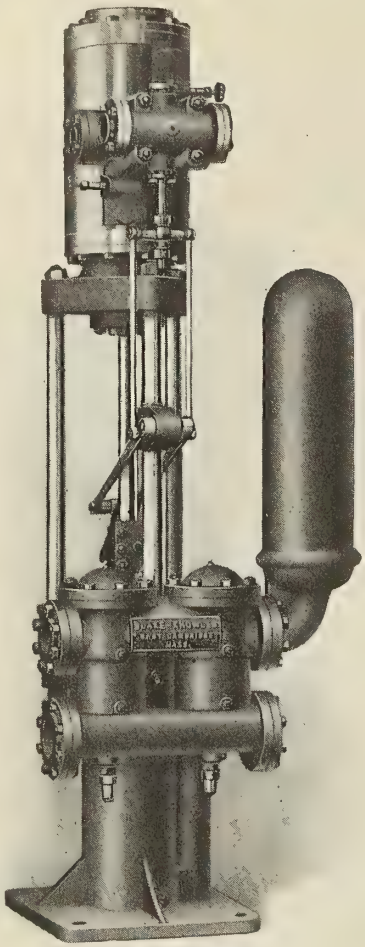

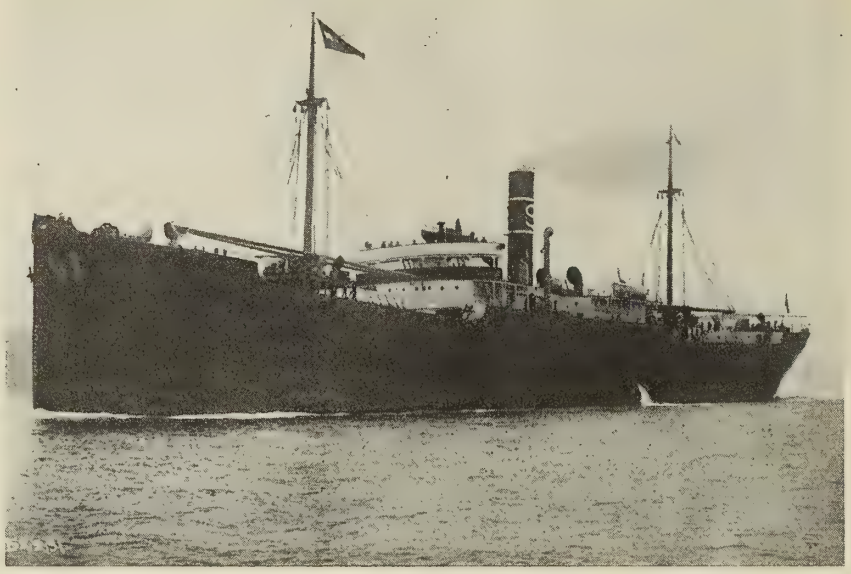

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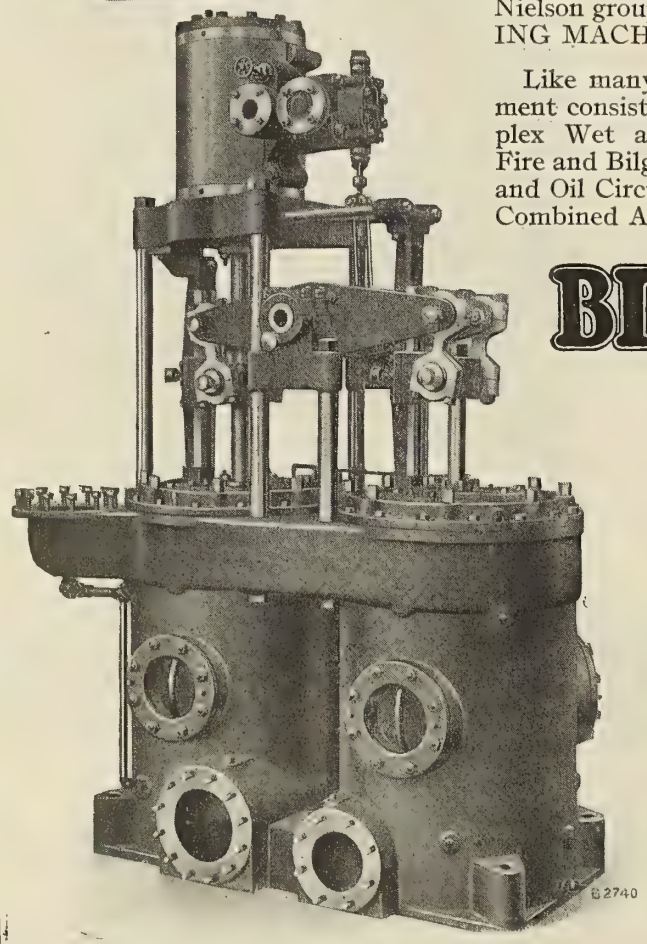

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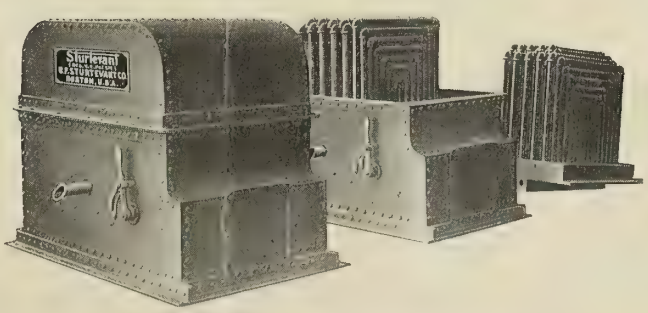

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INTERNATIONAL

MARINE ENGINEERING

JANUARY, 1917

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LONDON
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This magazine is member No. 448 of the Audit Bureau of Circulations.

4,000 *copies of this issue were printed.*

MARINE ENGINEERING may be purchased at the following News Stands:

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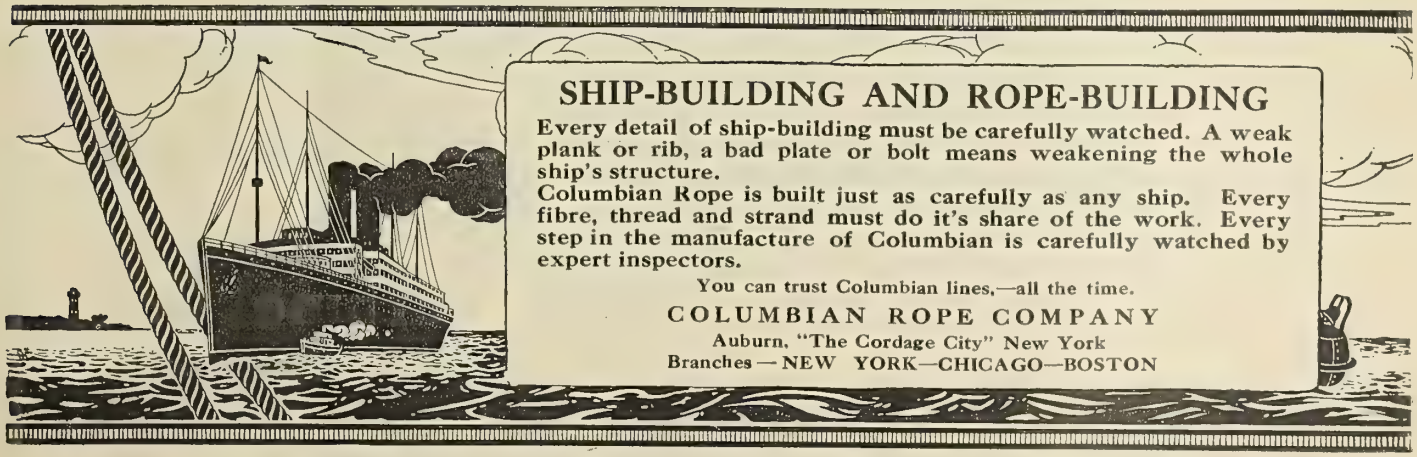

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Less oil required
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In operating auxiliaries on shipboard the items mentioned above are often considerable.

These items are reduced to an absolute minimum with

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Hartford **Connecticut**

T-383

TRADE PUBLICATIONS

The "Ohio" 14-inch heavy-duty shaper is described in a circular issued by the Ohio Machine Tool Company, Kenton, Ohio. "The 14-inch black geared crank shaper possesses an excess of strength for accurately machining the heaviest class of forge shop work at the maximum capacity of high-speed steel. (See general description on circular No. 115.) The single-geared 14-inch shaper is a machine of medium power, suitable for ordinary work. This circular gives complete specifications of both the back-geared and single-geared 14-inch machines."

"Fabroil" gears are described in an illustrated catalogue just issued by the General Electric Company, Schenectady, N. Y. "The General Electric Company presents to the entire machinery trade this collection of illustrations showing the great variety of applications for which Fabroil gears have been found peculiarly well suited. On all of these machines Fabroil gears are in constant service, and the manufacturers of most of them have adopted this form of noiseless gear as standard for their output. The invention of this remarkable gear was occasioned by the almost constant difficulty experienced with the motor pinion of a large punch operating in one of the General Electric Company's Schenectady shops under very aggravating conditions. Iron, brass, steel and the various non-metallic pinions had been tried. All but the steel wore out in a few days, and the steel produced an unbearable noise. For years the monthly maintenance bills for that one gear train were never less than $5 and occasionally amounted to $40. This condition resulted in the conception of the Fabroil gear, and the first experimental pinion was applied to this troublesome machine and proved a success. Moreover, this same Fabroil pinion has been driving the punch for five years, and to-day is giving satisfactory results. The punch and pinion are shown on page 23 of this bulletin. Remarkable for strength, elasticity of teeth and toughness, these gears will outwear iron or brass, and are proof against damage from water, oil, dryness or temperature changes. Fabroil gears have made silence possible in many a gear train in which no other material afforded adequate strength combined with silent operation."

Power hammers are described and illustrated in a catalogue issued by the United Hammer Company, 141 Milk street, Boston, Mass. "We are pleased to notify the trade that we have recently purchased the power hammer business of The E. & T. Fairbanks & Company, of St. Johnsbury, Vt., and are prepared to furnish complete Fairbanks power hammers of all sizes, for prompt shipment. We can also furnish parts and repair sections for Fairbanks hammers already in use."

"The Willett Bruce Steamship Whistle Control" is the title of an illustrated catalogue which has just been issued by the McNab Company, Bridgeport, Conn. "It is a somewhat remarkable fact that, with all the recent and far-reaching developments in the construction and fitting out of the modern steamship, especially in the department of aids to safer navigation, little or no consideration has been given to the familiar steam whistle. Perhaps it has been considered that this item forms such a small portion of a ship's equipment that any serious attention was unnecessary. When it is remembered, however, that under certain conditions, such as navigating in foggy weather or in crowded waterways, the whistle is, in many cases, the only means whereby the navigating officer may give warning of his approach or intended movements to neighboring vessels, it is at once apparent that some very careful consideration should be given to the whistle installation to ensure that it is at once efficient and reliable. We are all familiar with the feeble response which the general method of installation makes—a shower of water accompanied by a thin intermittent sound. This annoyance is not the fault of the whistle itself, but is caused by the construction and installation of the old-style whistle valve. So great have been the advantages of the Willett Bruce system that the British Government are installing it on their cruisers and transports, also practically every important shipbuilder is now making installation on new tonnage contracted for throughout the United States and Europe. Prominent naval architects ad engineers specify the Willett Bruce system, because they know there is no comparison when compared with the ancient valve-at-whistle 'hydraulic' arrangement. The British Board of Trade and Lloyd's have given the Willett Bruce installation their highest approval, because they know by the many installations on practically every transatlantic liner that it is a great aid to safe navigation."

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500,000 B. H. P. of Bolinder's Engines now in use in all parts of the world.

Present Sales and Yearly Output 70,000 B. H. P.

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The Vacuum Oil Co.'s Tanker "Bramell Point" fitted with 1500 B. H. P. Bolinder

BOLINDERS COMPANY, 30 Church St., New York

Pneumatic collecting and conveying systems are described in Catalogue 235 just issued by The B. F. Sturtevant Company, Hyde Park, Boston, Mass. This is a profusely illustrated and handsomely printed volume of 76 pages. The advantages of pneumatic systems are stated in the catalogue to be as follows: "In many States the collection of dust is compulsory by law, and where no definite State laws exist the same end is attained by board of health regulations. The adoption of such measures has been brought about by the prevalence of throat and lung diseases among those working in the dusty trades. Important as is the hygienic aspect, there are other considerations which make dust-collecting systems advantageous financially. The health of the workers is inseparably connected with their output and efficiency, and just as there is more work accomplished on a crisp October day than on a sweltering day in July, so a healthy workman, breathing good pure air, will do better work and more of it than the man who toils in atmosphere that is laden with irritating and offensive dust particles. In wood-working plants a clean shop constitutes an important factor in production. Machines littered with chips and shavings, and floors covered with refuse, delay operations and militate against an efficient day's work. In further connection with the dust nuisance it must be remembered that dust injures machinery, and particularly the bearings and working parts of fine machinery and electrical motors. Gritty dust scores and scratches the surfaces, greatly increases the wear, and makes much more lubricating oil necessary. In one plant we installed a system for removing gritty dust, and after it had been in operation for some time, the superintendent stated that the oil saving alone justified the expenditure. Insurance is another consideration that makes dust-collecting systems advisable. The presence of dust on walls, beams, rafters or shelves greatly increases the fire risk, and the underwriters fix heavy rates where such conditions exist. This applies with special force to the dust and shavings in wood-working plants, and the installation of a well-designed fan system will materially reduce the premium. A still further reason for the installation of a dust-collecting system is the severity of workingmen's compensation acts, and to avoid the payment of heavy indemnities, owners should avail themselves of this means to prevent accident or illness. Considered merely as an insurance premium the outlay is a good investment. In some trades dust explosions constitute a real menace, and frequently result in the complete destruction of the mill and in great loss of life. During 1914 the United States Government received reports of sixteen different disasters. The casualties were 80 people killed and 122 injured. The greatest danger from such explosions occurs among the carbonaceous dusts, including sugar, flour, starch, fine sawdust, coal soot, cork, charcoal, tanning bark, resins and celluloid. Adequate protection against this hazard can be secured only by a successful dust-collecting system. When it comes to conveying, substantial money savings are frequently possible if a pneumatic system is used. In one textile mill Sturtevant fans convey 50,000 pounds of cotton daily a distance of a quarter of a mile at a power cost of only $4.60. Think how much this would cost if conveyed by truck."

Wire rope is the subject of a folder published by John A. Roebling's Sons Company, Trenton, N. J. "There are more than 400 different sizes and constructions of Roebling wire rope. Among these are wire ropes for every service known to the mechanical engineer. These ropes have a distinctive quality, because they have been developed as the result of an experience of over three-quarters of a century spent by successive generations of Roeblings in making wire rope. We are in constant touch with the many fields of wire rope operation, and are ever ready, through our engineering department, to make suggestions or render any service that will assist in obtaining greater economy and efficiency in wire rope equipment."

The Ingersoll-Rogler Class ER-1 compressor is the subject of Form No. 3130 just published by the Ingersoll-Rand Company, 11 Broadway, New York. "In general appearance this type of air compressor resembles to a large extent the company's previous small straight line compressor types, with the exception of the air end; here resemblance to past design ceases. The distinguishing feature of the air end is the 'Ingersoll-Rogler' type of air valve, admitted to be the last word in air valve design. This valve is discussed at some length in this pamphlet further on; however, for a more complete description of its adaptation and advantages the reader is referred to Bulletin 3024. Suffice it to say here that the 'Ingersoll-Rogler' valve makes it possible to guarantee a performance heretofore not thought of in connection with compressors as inexpensive as the Class ER-1. In addition, certain improvements have been made in the driving end, which the company's long experience has dictated as desirable."

HIGHER SUPERHEAT MEANS GREATER ECONOMY

As the degree of **superheat increases** the rate of **coal saving increases.**

Condensation appears in the cylinders when **superheat disappears.**

For the most economical operation superheat is therefore essential in every cylinder, and can only be obtained by high initial steam temperatures.

The accompanying table which was presented by Mr. Harry Gray before the Institution of Naval Architects shows that 180° of superheat is not enough to provide superheated steam in the low pressure cylinder of a triple expansion engine; the same condition applies when made for a quadruple expansion engine and here 211° of superheat is not enough.

Steam Chest.	S.S. "Port Augusta." Triple-Expansion Engines.				S.S. "Port Lincoln" and "Port Macquarie" Quadruple-Expansion Engines.			
	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.
	lbs.	Deg. F.	Deg. F.	Deg. F.	lbs.	Deg. F.	Deg. F.	Deg. F.
High Pressure	160	370	550	180	206	389	600	+211
1st Intermediate	53	300	400	100	97	335	460	+125
2d Intermediate	—	—	—	—	38	284	290	+ 6
Low Pressure	10	240	?	?	9	237	220	

Our fire tube superheaters are capable of furnishing an initial superheat high enough to permit the completion of the expansion in all cylinders without condensation.

Our latest bulletin shows how the savings of 12 to 20% in fuel may be made available for your ships.

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New York **MARINE SUPERHEATERS** **Chicago**

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"How do you explain the remarkable fact that "for smokestacks, winches, anchors and all ex- "posed metal and wood work above and below "the decks Dixon's Silica-Graphite Paint lasts "longer, and therefore costs less per year of "service, than any other protective paint."

MOTHER NATURE REPLIED:

"Because Dixon's Silica-Graphite Paint is not "a mechanical mixture of the silica and graphite. "It is Nature's mixture of the flake silica- "graphite, mined only by the Dixon Company "at an American Mine and used by them with "the highest grade of pure, boiled linseed oil "for over fifty years as their unrivalled paint "film. The Dixon Company also performs its "part. It makes no secondary grade. It "grinds the flakes to great fineness so that the "film will be adhesive."

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Made in Jersey City, N. J., by the

JOSEPH DIXON CRUCIBLE CO.

ESTABLISHED 1827

B-133

"Burning Crude Oil" is the title of a bulletin issued by the De La Vergne Refrigerating Machine Company, 1175 East 138th street, New York. "One cubic inch of oil having 6,000 square inches of surface is hard to conceive. Yet this phenomenon occurs in the De La Vergne oil engine. The perfect spray valve and combustion chamber breaks up each cubic inch of oil by compressed air into particles less than one-thousandth of an inch diameter, and the aggregate surface of these small particles is more than 6,000 square inches. This enormous surface suddenly exposed to the high temperature in the hot combustion chamber produces complete and instantaneous combustion of the heaviest grades of oil. Think of it! One cubic inch of oil in bulk has a surface of only 6 square inches, but when broken up into such minute particles will present a combined surface of over 6,000 square inches, all exposed to the high temperature oxygen at the same instant. Throw a handful of gravel and note that the large pebbles travel the farthest. Likewise note how the heavier oil particles travel farthest and impinge on the hot vaporizer walls. In an instant they gasify and ignite the perfect mixture formed behind them. Grasp these principles and you will know why the De La Vergne oil engine alone will utilize the heavy tarry and cheap Mexican and Californian oils with no carbonization whatever, and develop 1 horsepower-hour on less than one-half pound of oil."

Milburn oxy-acetylene welding and cutting apparatus is the subject of a handsomely illustrated and printed catalogue of 32 pages just issued by the Alexander Milburn Company, 1418 West Baltimore street, Baltimore, Md. "Milburn oxy-acetylene apparatus for welding and cutting metals combines correct principles of design, high quality of construction and moderate first cost, offering every user efficient, lasting service at low operating expense. Throughout metal-working industries attention is rapidly being drawn to the many opportunities for economical application of the oxy-acetylene process. At the same time experience is showing the great importance of correctly designed and substantially built apparatus at a reasonable cost. The oxy-acetylene process has produced more revolutionary economies and improvements in metal working than any other single development of recent years. It is scarcely more than ten years old, but has already passed far beyond the experimental stage and into universal application. Among its most important uses are the following: Wherever joints or connections are made in the ordinary industrial metals, perfect, smooth connections are produced with strength equal to the metal itself. It replaces riveting, bolting, crimping, brazing, soldering and other forms of joints at lower cost. Many seams, connections and articles are produced which would be altogether impossible by other methods. Oxy-acetylene cutting is employed in manufacturing where steel plates, bars, structural sections or special parts are to be cut in irregular patterns or heavy sections are to be cut economically. Boiler and tank work is greatly simplified by oxy-acetylene welding and cutting, in the replacement of riveted and other joints, making openings, placing patches and in general repairs. Perfectly tight seams are secured which will stand heavy pressures and will not work loose under expansion and contraction."

Galusha gas producers for marine use are the subject of Bulletin No. 6, issued by the Nelson Blower & Furnace Company, Boston, Mass. "Owing to the perfection which has been attained within the last few years by the producer-gas plant, the gas engine offers the most economical scource of power now in existence. These gas producers have been perfected for use with American and Welsh coals to such an extent that they are now one of the most reliable sources of power at the service of the power user. The gas producer, as its name implies, is a simple machine for producing a gas suited for use in gas engines. The Galusha gas producer is a simple gas plan that makes gas from anthracite coal, which is suitable to run a gas or gasoline engine of the four-cycle type. Gas producers have been studied by the United States Bureau of Mines for the past ten years. The bulletins of this bureau will show the results obtained and confirm our statements as to fuel consumption. The difference between land gas producers and marine gas producers is that the latter must be much more compact than the land producers, and must also be so designed that the motion of the boat in a storm has no effect on their operation. The Galusha gas producer consists of the producer in which the coal is gasified, and the scrubber and drier which removes the dust and impurities from the gas, delivering cool gas to the engine. The fuel used is anthracite pea coal, charcoal or coke. The suction principle is used, and the down stroke of the engine pistons draws the gas from the producer and through the scrubber and drier, where it is cleaned and cooled, then, through a mixing valve and into the engine cylinders. Hence the volume of the gas made is determined and controlled by the engine itself. When the engine stops the gas-making in the producer is checked. As the whole device is under a slight vacuum a leak is not dangerous, as air will go in a leak instead of gas coming out. There is no danger of explosion from producer gas."

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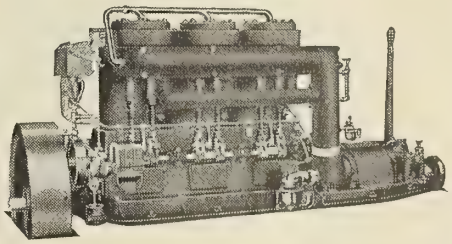

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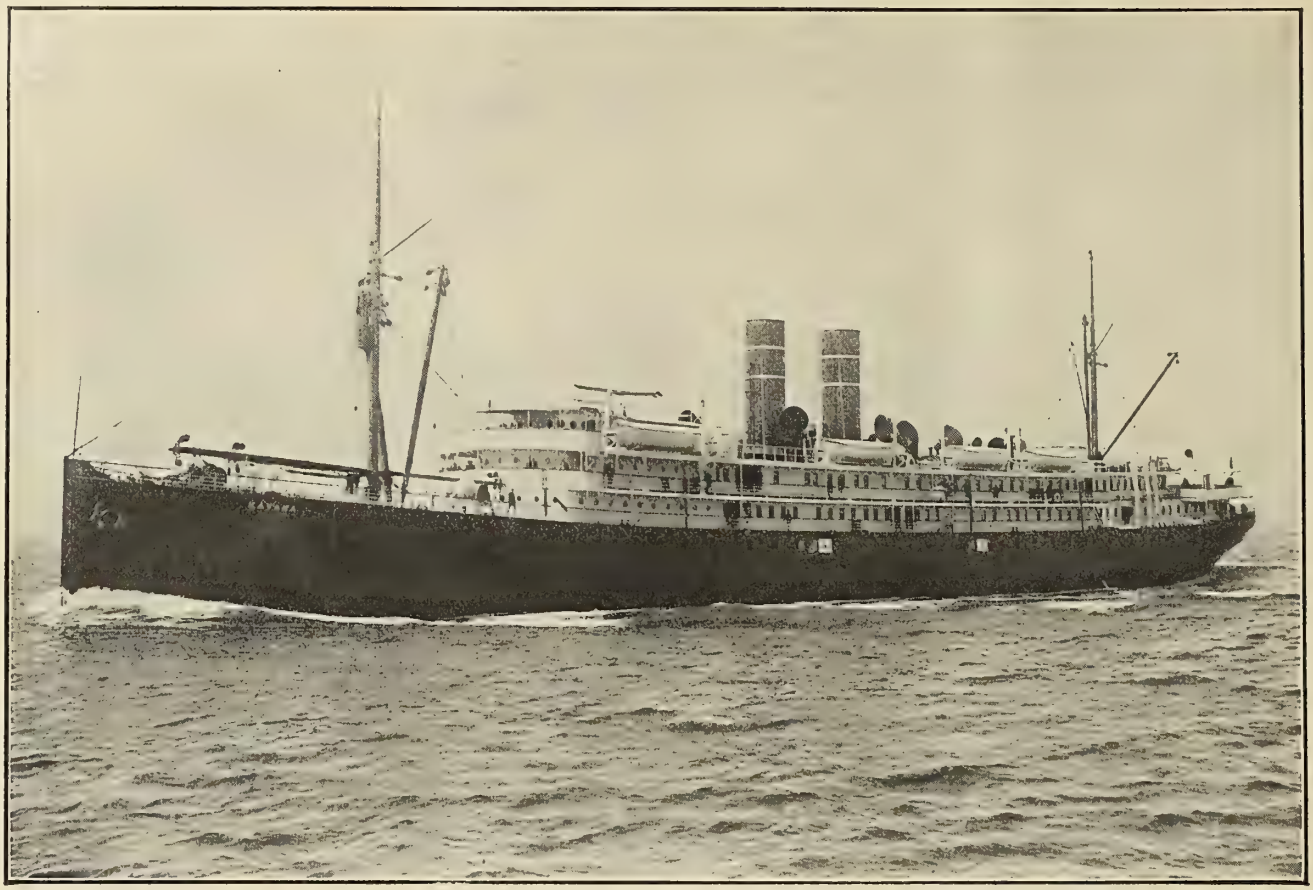

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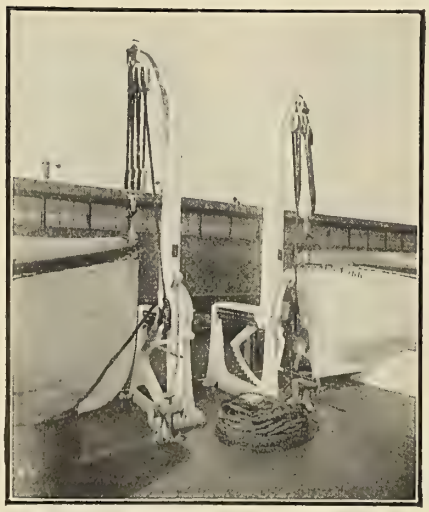

Boat deck on S. S. "Havana".

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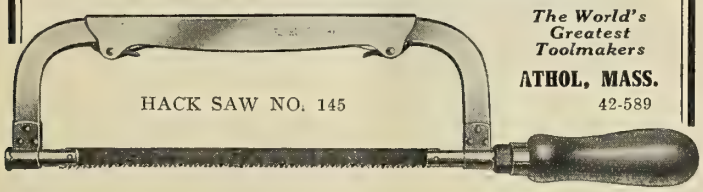

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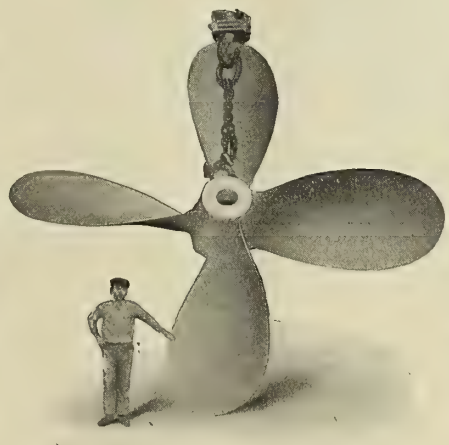
All sizes from 10 inches to 20 feet in Diameter



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HOLMESBURG, PHILADELPHIA, P A.

Mechanical rubber goods are described in a catalogue just issued by the Peerless Rubber Manufacturing Company, 31 Warren street, New York. This company makes rubber goods for every conceivable marine purpose, and a copy of the catalogue should be in the hands of every marine engineer, shipbuilder and naval architect.

Reinforced concrete docks are described and illustrated in a catalogue published by the Cleveland Dock Engineering Company, Citizens building, Cleveland, Ohio. The catalogue states that Cleveland docks are rigid engineering structures, built out over the water and tied back integrally into the shore. Underscour and eddies are eliminated. "The greater the load and back fill the more the dock runs into place with direct compression of the piles. In resisting the thrust of moving boats, all factors, girders, floor piles and back fill act as an integral unit to develop maximum resistance. Cleveland docks are permanent structures, wrought rust and fireproof."

"Marine Auxiliaries" is the title of an interesting and valuable sectional catalogue which has just been published by the Schutte & Körting Company, 1253 North Twelfth street, Philadelphia, Pa. This is a very concise and handsomely printed catalogue, and should be in the hands of all marine engineers, naval architects and shipbuilders. Among the great variety of marine auxiliaries described and illustrated are injectors of many types, bilge syphons, water-jet eductors, oil burners suitable for marine boilers of all types, valves of many descriptions, including the Auld "Quitetite" reducing valve, evaporators, distillers, boiler feed water heaters and thermofans for heating, cooling and ventilating merchant ships and naval vessels.

"Eight Reasons Why" is the title of a circular published by the Locomotive Superheater Company, 30 Church street, New York. The eight reasons given in this circular why the company's firetube marine superheater should be used are as follows: "1. It is adaptable to either new or existing boilers of the firetube type and can be applied with no change in design or construction; 2, it renders possible increase in output of boiler horsepower from a given boiler plant 10 percent to 20 percent; 3, it will produce the same power output with few boilers; 4, it reduces the size of the bunkers, thereby reducing the draft of the vessel with a given cargo or making possible an increase in revenue cargo; 5, it results in a saving of fuel over saturated plants, both operating under the same draft conditions of 10 percent to 20 percent; 6, it reduces the maintenance costs by the prevention of water hammer, leaky flanges and condensation in the cylinders; 7 it does not prevent rapid, thorough and frequent cleaning of the tubes; 8, its costruction provides easy access to all screwed joints and the easy removal of the parts."

Ship machinery, steam and hand windlasses, steering engines and steering gears, steam winches and hoisting engines, pumps, etc., are the subject of a handsomely printed and illustrated catalogue of 148 pages, published by The Hyde Windlass Company, Bath, Me. The introduction to the catalogue reads as follows: "In submitting this catalogue to our customers and the trade we desire to state that we have largely increased our facilities for the manufacture of our improved ship machinery. By the addition of new and special tools and labor-saving appliances, and by making such improvements in the details of construction as our experience has suggested, we have greatly increased the good qualities and added to the appearance of our machines, and now offer them as the standard. Our prices are as low as is consistent with first-class workmanship and materials. We do not place our machinery in competition with poor and cheaply made machines, but invite a careful comparison of their merits with those produced by the best-known builders of similar work. Materials and workmanship—The materials used in the construction of our machinery are those found by years of practical experience to be the most suitable and best adapted for such work, and are throughout of the best quality. We employ none but the best and most experienced workmen. All labor is done by the day, no job work being allowed, and all work is under the supervision of competent foremen. All working parts are carefully scraped and made to fit accurately. All machinery is so designed that by the aid of special tools we are able to insure absolutely perfect alignment. Weight and strength—While we have endeavored to keep down the weight as much as is consistent with the severe usage machinery of this class is subjected to, special attention has been directed toward distributing the stock in such a manner that every part of the machine shall be capable of withstanding the severest strains that are likely to be brought to bear upon it. We guarantee all work as represented, and any failure on the part of any of our machines to perform all we claim for them will be promptly met in a satisfactory manner."

Large and complete stocks of finished steel products of all kinds are in the warehouses of Joseph T. Ryerson & Son, Chicago, Ill., ready for immediate shipment. These stocks include, among other material for boiler makers, bars, shapes, plates, sheets, rivets, bolts, nuts, tubes, tool steel Babbitt metal and machinery of every description.

Marine refrigerating machines are the subject of a catalogue published by The Clothel Company, 61 Broadway, New York. "There are no valves or springs to cause trouble. Suction and discharge ports are cast in the walls of the outer cylinder. The rotor, mounted eccentrically in the cylinder, forms a line of contact with it at the top. Suction and compression is accomplished by the blades, which form a continuous bearing surface against the cylinder, and slide in and out of their slots as the rotor revolves. The Clothel rotory compressor will maintain a vacuum of 29½ inches under normal atmospheric conditions. While this machine is an integral part of the Clothel refrigerating system, it can be furnished separately for use as a vacuum pump. It offers to power-plant engineers a highly efficient vacuum pump of the greatest simplicity."

"99 Engineers in 100."—This is the title of a pamphlet published by the Leavitt Machine Company, Orange, Mass. We quote in part as follows: "Ninety-nine engineers in 100 say: 'Sure, my pumps are all right.' But are they all right? To analyze the situation, let us ask you—how do you know that your pumps are not making too many strokes—that they are not using too much steam? Just look at the valves in the fluid end. Probably you haven't examined them for a long time, merely because the pump has gone on month after month without attention or trouble. Look at them to-day. If the seats don't need refacing your pump is an exception. Because nearly nine out of every ten pumps that come under our observation have leaky valves. The seats need recutting."

Hydraulic valves and fittings are described and fully illustrated in a catalogue of 96 pages just published by the Watson-Stillman Company, Box 26, Roselle, N. J. "Our line of hydraulic tools is so general and the illustrations of the various machines so numerous that we find it convenient to divide the tools into classes, making each class the substance of a catalogue. At the back of this book is a list of these classified catalogues, any of which will be mailed upon application. We have built a great number of special tools which cannot be included in our general classes, and are therefore not advertised. If the manufacture of your product demands a special apparatus we would remind you that our large equipment and experience have particularly qualified us to design and build the best tool for your requirements."

Single compressors, steam driven, are the subject of Bulletin 34-Z, published by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago, Ill. "For sixteen years the Chicago Pneumatic Tool Company has maintained a reputation as the maker of air compressors of the highest quality. All that the finest materials, the most modern engineering facilities and practice can contribute toward the construction of a compressor is found in Chicago pneumatic machines. The production of the Simplate air inlet and discharge valves, stamped this company once and for all, as one of the recognized leaders in the compressed air field. These valves have made possible very high compressor speeds and efficiencies—as high in fact as any known. They are the only valves of concentric plate construction obtainable in American-made compressors. In less than two years 20,000 of them have been placed in service without a single serious complaint resulting or cause being shown for any material modification in design. Because of the proved effectiveness of the valve, the sales of Chicago pneumatic compressors in this same period of time have increased greatly. This bulletin deals with a new and very efficient machine—the Class N-SS automatic high-speed steam-driven compressor. The company believes that the constantly-increasing sales of its steam-driven compressors are due to the correctness of their design and their fine operating qualities, and in offering this new machine it assures the public that the N-SS automatic not only maintains but increases the company's standards of excellence."

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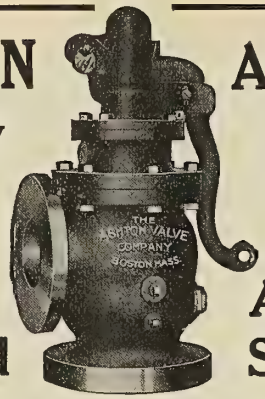
Pop Safety Valves
The Quality Standard



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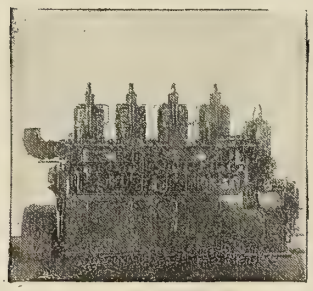

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Walloon welding wire is described in a circular issued by the Apex Steel Corporation, 50 Church street, New York. This wire is claimed to make a strong, durable, homogeneous weld, to fuse at lower temperature than ordinary wire and to flow evenly. Free samples will be sent upon request.

The Peerless high-speed metal saw is described in a circular issued by the Peerless Machine Company, Racine, Wis. "The Peerless high-speed metal saw is not a novelty. Seven years ago its designers brought out a metal cutting machine which upset all metal cutting standards. The demand was unusual and thousands of the first model are in use to-day. A second machine is now perfected embodying seven years of metal cutting experience and showing results far more revolutionary. There are no untried principles; no novelties of design; perfection is obtained by ingenious combination. Description is inadequate; only actual use or inspection can give a true idea of the perfection reached in the Peerless high-speed metal saw."

An oxy-acetylene and oxy-hydrogen machine for cutting steel plate, billets and heavy risers has been placed on the market by the Davis-Bournonville Company, Jersey City, N. J. It is called the Radiagraph. "The Radiagraph is an oxy-acetylene or oxy-hydrogen cutting machine for cutting steel plate, billets and heavy risers. It combines a carriage, motor driven, with adjustable speed, the Davis-Bournonville machine-cutting torch with interchangeable tips and electrical connections, the torch adjustable to height and angle, with adjustable arm for guiding torch along an irregular line, oxygen and acetylene or hyrdogen regulating valves, with pressure gages, hose and connections, a rod and center for circular cutting, and double-grooved track for straight-line cutting. The cutting is done with the oxy-acetylene or oxy-hydrogen flame. Steel plate from ¼ inch thick up to 20-inch armor plate is cut at a speed varying from 18 inches to 4 inches per minute, according to thickness of steel. Plate can be cut with straight edge or beveled edge, as desired. The Radiagraph is used for cutting armor plate, trimming steel plate, cutting discs, washers and pipe flanges, cutting and nicking steel billets, and for a great variety of miscellaneous steel cutting, in steel mills and foundries, navy yards, ship yards, fabricating shops, scrap yards, etc. Complete only with the Davis-Bournonville torch."

Portable electric hoists are the subject of Bulletin E-45, just issued by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago, Ill. "Of all the various hoisting and conveying appliances the electric hoist is the most universal in scope and the most easily applied. The energy required to operate is insignificant, while the rapidity of operation and ease of control of a well-designed electric hoist render it far superior to any other type. The Duntley electric hoists fulfill these conditions and are in successful operation in many foundries, machine shops, etc., throughout the country."

"The Stock List and Reference Book," published by the Scully Steel & Iron Company, Chicago, Ill., is a publication which should be in the hands of every one interested in boiler making and any branch of the iron and steel business. The company states that it is the only publication of the kind which contains valuable information, as well as a statement of stock in hand. In issuing this book, which consists of 144 pages, it is the company's purpose to give the trade something which will aid them in figuring on jobs, as well as giving complete information in reference to stock in hand. A copy of this book will be sent to any of our readers free upon request. Following is a list of some of the products handled by the Scully Steel & Iron Company: Boiler, tank, bridge and universal plates; Scully wrought steel floor plates; black and galvanized sheet steel; planished iron, Wellsville polished; ternes and electrical sheets; corrugated sheets and roofing steel; lapwelded and seamless steel and charcoal iron boiler tubes; boiler, structural and sheet iron rivets; beams, channels, angles and tees; steel bars, bands, hoops and tires; cold rolled and turned steel shafting; Merchant bar iron, Norway iron and staybolt iron; machine, carriage and boiler bolts; lag screws, turnbuckles and bolt ends; hot pressed, cold punched and semi-finished nuts; wrought, cast and malleable washers; Scully weldless steel boiler braces; lugs, hangers, buckstays and ferrules, flanges, staybolts, etc.; "Everlasting" blow-off valves; tube expanders, tube cutters, tube cleaners; iron workers' and boiler makers' hand and power tools; iron workers' and boiler makers' hand and power machinery; vises, anvils and jacks; chain, electric and pneumatic hoists; rivet forges and blowers; pneumatic tools, etc.

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Adopted by Pennsylvania Railroad Company

and used for covering ceilings and side walls as protection against fire in Team Gangways on reconstructed ferry boats, PITTSBURG, ST. LOUIS, and NEW BRUNSWICK.

MANUFACTURED BY **THE KEYES PRODUCTS CO.** EQUITABLE BUILDING, NEW YORK CITY, N. Y.

A pump valve reseating machine is described in an illustrated catalogue just issued by the Leavitt Machine Company, Orange, Mass. "Every engineer sooner or later becomes aware of the fact that his pumps are in a defective condition, due to valve seats becoming worn or badly scored, with a consequent loss of efficiency through leaky valves. Users of the improved Dexter pump valve reseating machines can reseat their valves without removing them at little expense and no trouble at all, making the valves perfectly tight, resulting in the pumps doing their fullest duty. The illustrations in this supplement show complete outfits for reseating pump valve seats, which are used independently of the Dexter valve reseating machine."

"Drilling Machines" is the title of a 36-page booklet published by the Henry & Wright Manufacturing Company, 760 Windsor street, Hartford, Conn. We quote in part from the description of the company's Class B drilling machine: "This class contains many decided improvements, including all the useful ideas that the designers could collect. They have increased weight and rigidity, in order to more efficiently drive high-speed drilling tools. The bases are lowered and the pillars raised in order to produce a better balanced design, and one that would more nearly fit the average size man without interfering with their use by the tallest man, and the strength of the machines was in this way largely increased and more evenly distributed. A flange is provided around the floor piece to catch the oil drip. The width and depth of the oil channel around the table is doubled, and a guard is provided at the back of the table to keep dust and chips out of the table ways, and to prevent fixtures and pieces being drilled from striking and injuring the ways. The new patented belt shifting device will shift the belt from any degree of the circle surrounding the drive pulley desired."

Information on lubrication of pneumatic tools is given in Bulletin No. 130, just issued by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago, Ill. "Unless pneumatic tools are kept clean, well lubricated and limited to the uses for which they are intended, they will not give the service for which they are designed. To keep the working parts of the tools clean and free from particles of foreign matter, the first thought should be given to the air itself. Wherever possible the air supply should be drawn from some point outside the building, where the air is most apt to be clean, cool and dry. In any event, a strainer should be placed over the exposed end of the inlet pipe. Such a strainer can be easily made by covering the opening with wire netting over which one or two layers of muslins have been placed. While under ordinary conditions the strainer is not essential, it helps to avoid a great many possible lubrication troubles, and not only adds to the life of the valves, piston and glands of the air compressor, but assists in keeping the dirt and grit out of the working part of the tools. A strainer should also be placed in the pipe lines leading directly to the pneumatic tools, and special strainers are made to insert between the pneumatic hammers and the hose nipple. In the lubrication of pneumatic tools judgment should be used, for there are some machines or portions of them that require a light machine oil and others that require a heavy grease. Valves and pistons for both hammers and drills require a light machine oil such as our Airoilene, and as the compressed air which comes in direct contact with these parts has a tendency to drive the lubricant out through the exhaust it is advisable to oil such parts freely and often, say every hour, while the tool is in constant use. Such portions of the tools as the gear and crank cases of 'Little Giant' drills to which the compressed air does not have direct access are best lubricated with grease such as our Airoilene grease. This grease may be forced into the crank cases through the dead air handle by means of a squirt gun or syringe or by the use of the 'Little Giant' grease machine. A filling every ten hours while the drills are in constant use gives the best results. It is a good plan to immerse pneumatic hammers in a bath of benzine or kerosene over night and then blow them out under pressure the following morning, after which they should be thoroughly lubricated with Airoilene. Keeping the tools clean helps the good work of lubrication, and users of pneumatic tools will be well repaid for any efforts they may expend along these lines."

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Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Wanted to buy one or two second-hand compound or triple-expansion marine engines, 150 to 200 horsepower each. *H. L. Lazarus, Jr.*, 313 Whitney Building, New Orleans, La.

Marine engineer open for engagement as chief draftsman or assistant to chief engineer. Technical graduate; mechanical designer of wide experience; member A. S. M. E. At present employed in responsible supervisory position in shipyard. Address *Technical*, care of MARINE ENGINEERING.

For Sale—Bound volumes MARINE ENGINEERING, 1908-1911; loose copies to date; *Boiler Maker*, 1911, bound; Holm's Practical Shipbuilding; complete set ship curves. Bargains. Address *Box* 61, *Montague, N. C.*

Naval architect and marine surveyor is available for appointment as naval architect, shipyard manager, surveyor or marine superintendent. Has had eighteen years' experience (mostly British) of naval and mercantile, design, construction and repair. Address *Experience*, care of MARINE ENGINEERING.

British and European Representation.—Advertiser is open to represent first-class American houses in goods connected with shipping and yachting (internal combustion engines and all kinds of gear). Has extensive connection in the United Kingdom, France and Holland. References to bankers and leading business houses. *Archd. H. Reid*, Newcastle Chambers, Southampton, England.

"Facts! Not Mere Arguments," according to the Ford Chain Block & Manufacturing Company, 139 Oxford street, Philadelphia, are published in their catalogue just issued. This catalogue fully describes and illustrates the Tribloc Chain Hoist. It is stated in this catalogue: "We are giving the purchaser a guarantee that really protects, a fact which proves our own confidence in the Tribloc and the claim we make for it."

BUSINESS NOTES

THE LIDGERWOOD MANUFACTURING COMPANY, 96 Liberty street, New York, has opened a branch office in the Hibernian building, Los Angeles, Cal. Mr. Charles A. Bechtold is in charge.

A NEW FIRM, Young, Rakestraw & Ferguson, consulting engineers and naval architects, have opened offices in Wilmington, Del., at 826 Adams street. Mr. Benj. P. Young, of the new firm, writes MARINE ENGINEERING as follows: "We have opened temporary offices in Wilmington, and hope soon to move to more central offices in New York. Mr. Rakestraw is a graduate of Michigan University and studied under Professor Sadler. He has great experience in pleasure and racing motor yachts. Mr. Ferguson received his experience on the Clyde, in the shops and offices, making a specialty of dredges, hoppers and shallow-draft steamers. Mr. Young also received his experience on the Clyde, in the shops and drawing offices, specializing in oil tankers, freighters and fast passenger steamers. All three have had an experience of many years in American ship yards. We have on hand at present designs for three motor wood ships to carry 1,800 tons deadweight for the West Indian trade, two suction dredges for the Mississippi River, and two 7,500 tons deadweight for foreign owners. The contracts for these ships are yet to be placed. We are also preparing the working plans for smaller ship yards, wood or steel, which do not wish to equip a drafting room, and are getting up specifications for superintending and surveying all kinds of vessels."

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INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
The Minories, Tower Hill, London.

THE TERRY STEAM TURBINE COMPANY, Hartford, Conn., has appointed Stephenson & Nichols, Monadnock building, San Francisco, Cal., its representatives in Northern and Central California and the northern part of Nevada.

J. A. & W. BIRD COMPANY, 88 Pearl street, Boston, Mass., distributors of Ripolin enamel paint, have arranged to have Mr. George Price, 120 Broadway, New York, who has been manager of that office for some years, handle the sales department covering the entire territory south of New York as far West as the Mississippi River, and also including Louisiana and Texas.

FOR RUSSIAN TRADE.—The Shipbuilding Joint Stock Company, "Noblessner," of Petrograd, Russia, asks MARINE ENGINEERING to request firms engaged in the manufacture of articles of ship equipment, or goods and machinery relating to the shipbuilding business, to send their catalogues or publications in duplicate, stating the name and address of their representative in Russia or elsewhere to whom inquiries should be addressed. Communications should be addressed to Shipbuilding Joint Stock Company, "Noblessner," Petrograd (Russia), Sampsonievsky quay 3.

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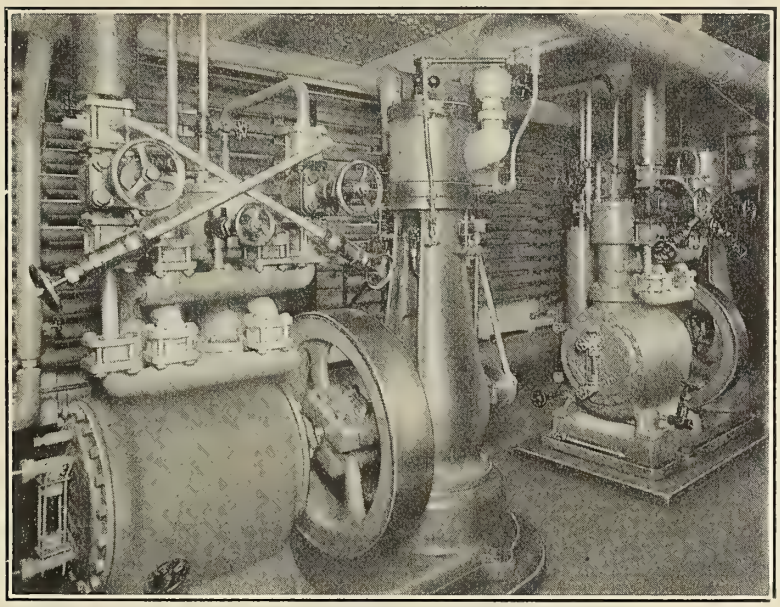

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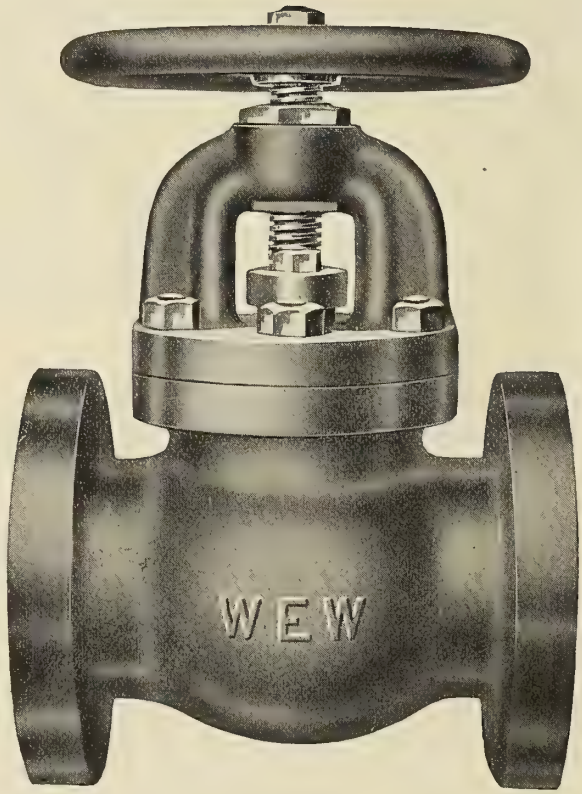

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10,000-Ton Shelter Deck Freight Steamer
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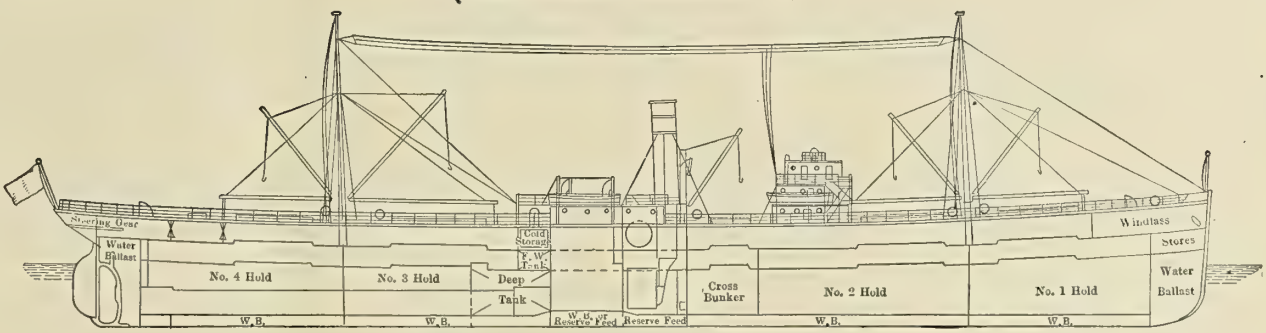
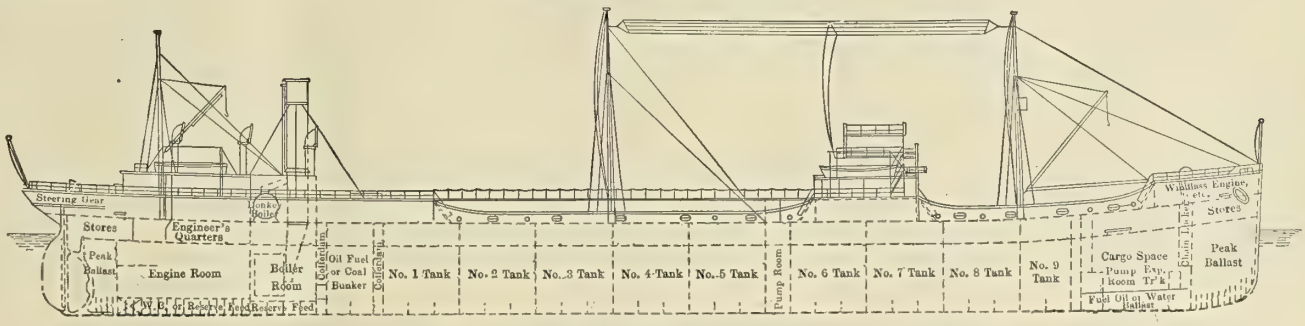


10,000-Ton Tank Steamers
(Code Word, OILER)



8,000-Ton Shelter Deck Freight Steamer
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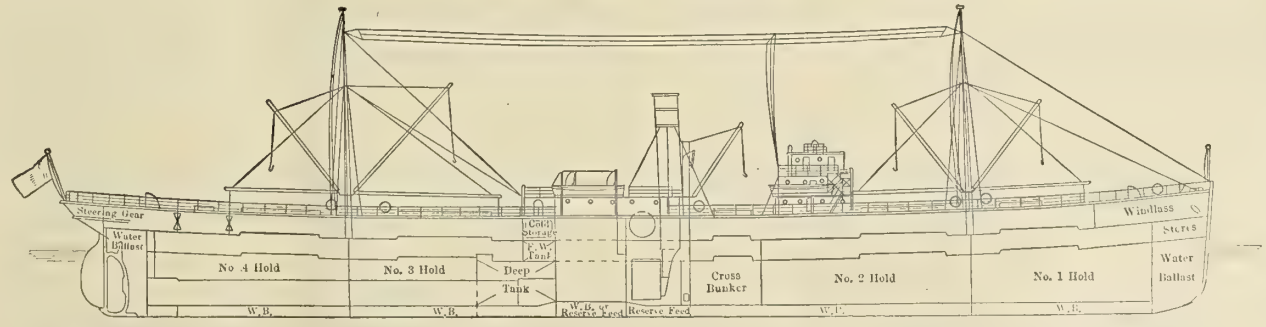

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NEARLY 90% AND STILL GOING UP!

From the Candle to the Electric Light

¶ Progress is the order of the day—in the production of Pipe as well as in anything else.

¶ As an example: Steel Pipe was first made in 1887; the tonnage of about 300 tons was practically negligible.

¶ Today, however, Steel Pipe represents almost 90% of the total tonnage of screw-joint pipe made in this country—and the progress made in the production of "NATIONAL" Pipe is leading the procession.

¶ The following figures, taken from the Special Statistical Bulletin No. 3 (1916) of the American Iron and Steel Institute, are eye-openers to the progress of Steel Pipe.

PRODUCTION OF IRON AND STEEL SKELP IN THE UNITED STATES FROM 1905-1915. GROSS TONS.

Year	Iron	Steel	Total	Per Cent. Iron	Per Cent. Steel
1905	452,797	983,198	1,435,995	31.5	68.5
1906	391,517	1,137,068	1,528,585	25.7	74.3
1907	444,536	1,358,091	1,802,627	24.6	75.4
1908	297,049	853,534	1,150,583	25.8	74.2
1909	370,151	1,663,230	2,033,381	18.2	81.8
1910	350,578	1,477,616	1,828,194	19.2	80.8
1911	322,397	1,658,276	1,980,673	16.3	83.7
1912	327,012	2,119,804	2,446,816	13.3	86.7
1913	312,746	2,189,218	2,501,964	12.5	87.5
1914	264,340	1,718,091	1,982,431	13.3	86.7
1915	262,198	2,037,266	2,299,464	11.4	88.6

¶ From these figures the following deductions are drawn:

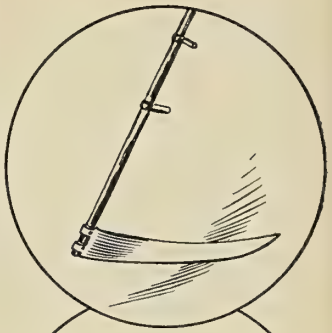
(1) The percentage of steel to the entire production of skelp for the manufacture of wrought pipe during the year 1915 is higher than any previous year.

(2) Not only is the percentage higher, but the steel skelp produced during 1915 was exceeded previously only by the productions of 1912 and 1913.

(3) Beginning with 1905 (the first year in which separate statistics were gathered) there has been a steady increase in the percentage of skelp to the entire production of skelp for the manufacture of wrought pipe.

¶ THEREFORE, it seems evident that steel pipe—"NATIONAL" Pipe—can legitimately lay claim to the title "THE MODERN PIPE," for it is distinctively a PRODUCT OF PROGRESS.

¶ **"The Rise of Steel Pipe"**—Send for a copy of "NATIONAL" Bulletin No. 24 if you are interested.



From the Scythe to the Mowing Machine

From the Old Roman Messenger to the Telephone

From the Stage Coach to the Modern Limited

NATIONAL TUBE COMPANY

General Sales Offices: Frick Bldg., Pittsburgh, Pa.
District Sales Offices in Larger Cities

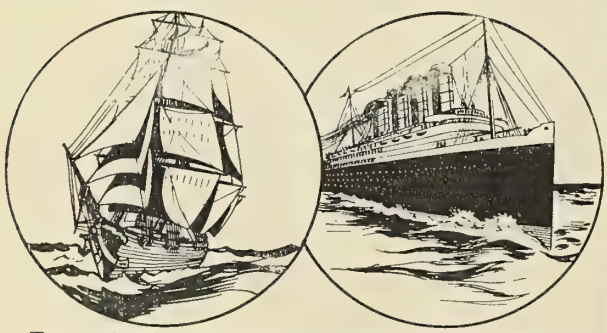
¶To readily identify "NATIONAL" material and as protection to manufacturer and consumer alike the practice of National Tube Company is to roll in raised letters of good size on each few feet of every length of welded pipe the name "NATIONAL" (except on the smaller butt weld sizes on which this is not mechanically feasible on the smaller butt weld sizes the name "NATIONAL" appears on the metal tag attached to each bundle of pipe)

¶When writing specifications or ordering tubular goods, always specify "NATIONAL" pipe, and identify as indicated

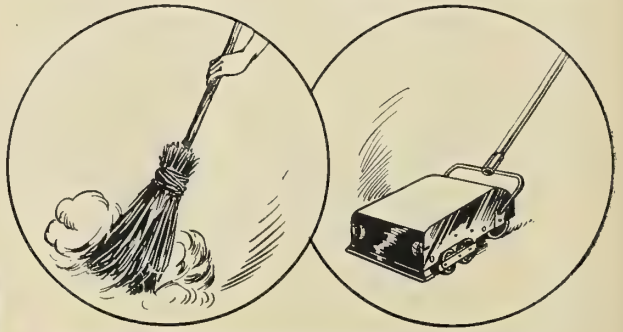
¶In addition, all sizes of "NATIONAL" welded pipe four in and under are subjected to a roll-knobbling process known as Speller-wrought-lessen the tendency to corrosion especially in the form of pitting. This Speller-ing process is peculiar to "NATIONAL" pipe, to which process National Tube Company has exclusive rights.

¶"NATIONAL" pipe was awarded the GRAND PRIZE (highest possible award) at Panama Pacific International Exposition, 1915.

AWARDED GRAND PRIZE



From the Sailing Vessel to the Modern Liner



From the Broom to the Vacuum Cleaner

Plymouth Rope removes the risk

IN figuring the size, number and resistance of the rope stops needed to control a vessel's velocity at launching, calculations are naturally based on the assumption that the rope used will be uniform in strength. And if it isn't, watch out for trouble!

Most builders rely on Plymouth Manila for this important work. It's the one Manila Rope that's *always up to standard.* Made by

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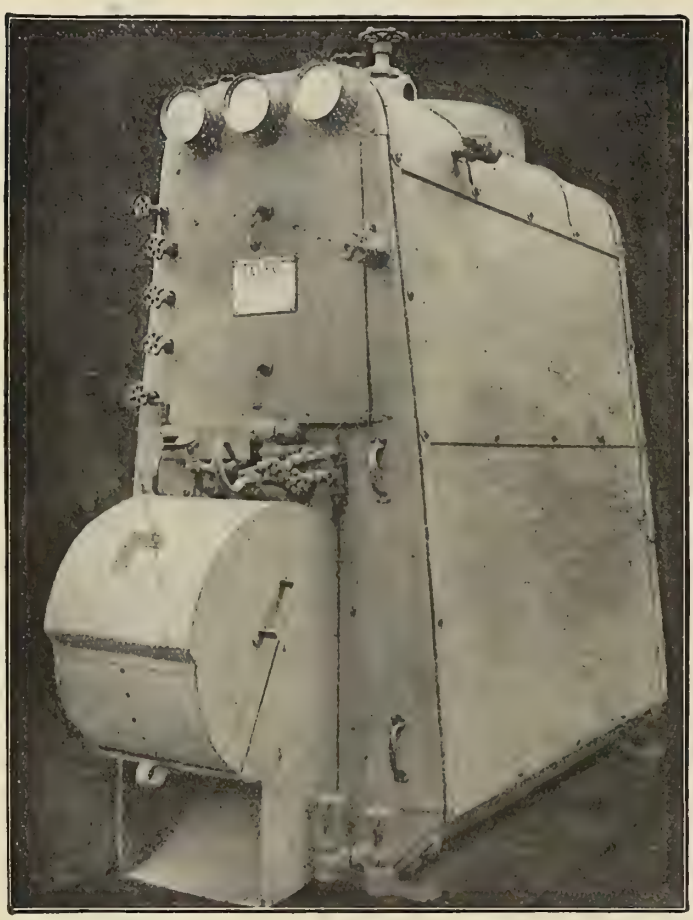
TALBOT
STEAMERS



This boat is equipped with a 150 H. P. Talbot boiler, which weighs 7500 pounds and is 3½′ x 6′ x 6′ high. This boat is operating in New York harbor at 90c. an hour. Normal price of fuel used is $1.00 per barrel of 42 gallons. This same boiler with a triple expansion condensing engine delivers 300 H. P. at the same cost.

This boat was formerly equipped with heavy oil engines.

TALBOT BOILERS may be seen running in many boats in various parts of the country and in New York harbor.

TALBOT BOILERS are built in sizes from 50 H. P. up.

OPERATING COST 50 H. P. Talbot complete plant costs 15c. per hour to operate including lubrication when crude oil is $1.00 per barrel; 75 H. P. costs 23c.; 100 H. P., 30c. All Talbot complete power plants operate for three mills per horsepower hour.

WEIGHT—50 pounds to the H. P. for all propelling equipment.

SPACE—Less space is required than heavy duty gasolene engines.

DELIVERY—Four to six months required for complete plants; three months for boilers.

FUEL USED—Talbot boilers use the cheapest grade of crude or fuel oil. May we send you our "Bulletin A?"

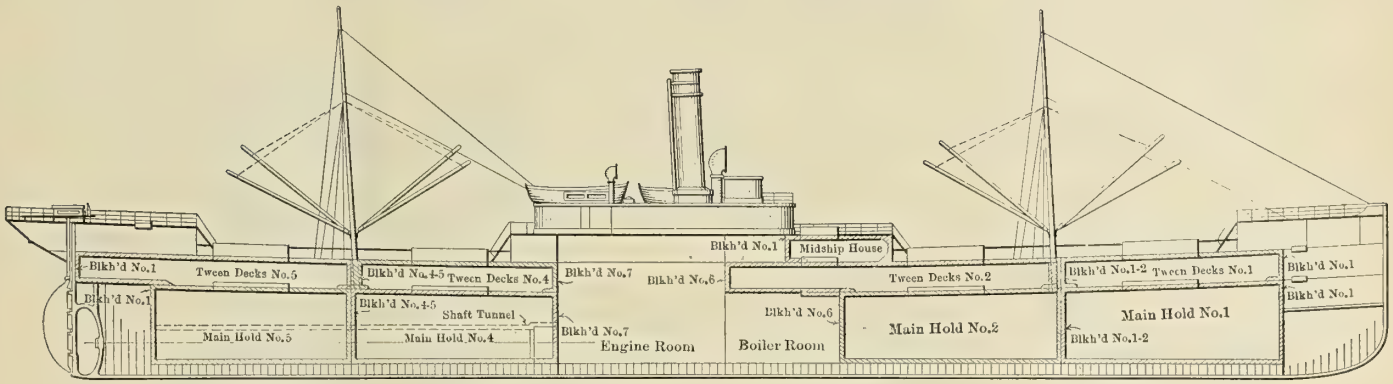
The steam launches on both the battleships "Arizona" and "Pennsylvania" are equipped with Talbot boilers. Talbot boilers have been in use in the Navy for several years.

Talbot boilers are a simple, sensible, very easily controlled arrangement of heating surface, using single-ended, straight tubes and crucible-cast steel headers, which are connected together to form an economizer steam generator and steam superheater of the most compact form.

All types of marine steam engines can be operated in conjunction with Talbot oil-burning boilers at a saving that no steamship owner can afford to overlook. The savings made are due to the use of oil fuel, increased efficiency of the boiler and engine, reduced number of firemen, the elimination of delays for boiler cleaning and repairs.

TALBOT BOILER COMPANY, 120-122 LIBERTY ST. NEW YORK CITY

FREEZERS



Inboard profile showing insulated compartments of steamer fitted with "YORK" CO_2 machines for carrying meat.

We design, construct and install Refrigerating Plants of *any capacity*, from ½ ton up, for *any purpose*, complete with necessary insulation.

We can furnish either *Ammonia* or CO_2 brine on direct expansion systems.

SHIPLEY CONSTRUCTION AND SUPPLY COMPANY

Marine Department

Foot of Warren Street

Brooklyn, New York

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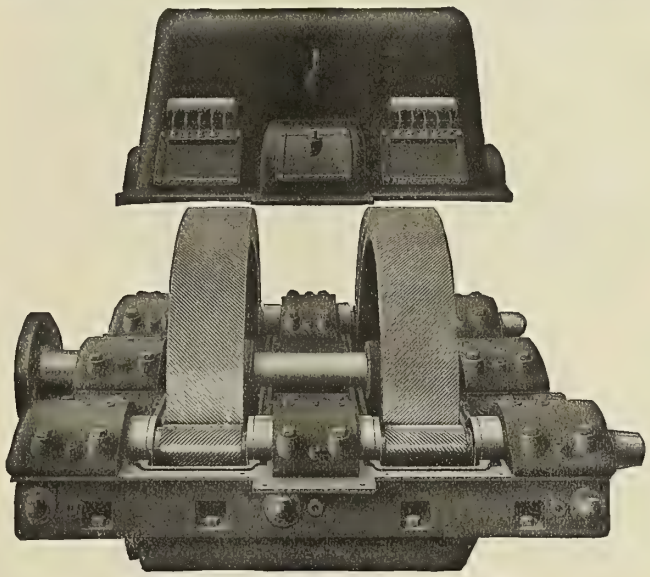
This Bureau supervises the construction of vessels throughout under established Rules, tests all materials for Hulls, Machinery and Boilers, and proof tests all anchors and chains, etc.

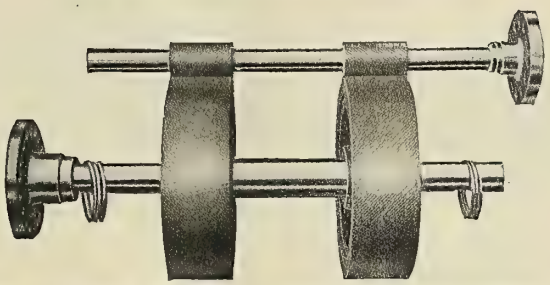
It issues for vessels, a Certificate of Classification, which is a receipt for Builders, a guaranty for Owners, an authority for Underwriters and a business guide for Shippers.

De Laval Speed Reducing Gears Are Properly Cut And Properly Supported

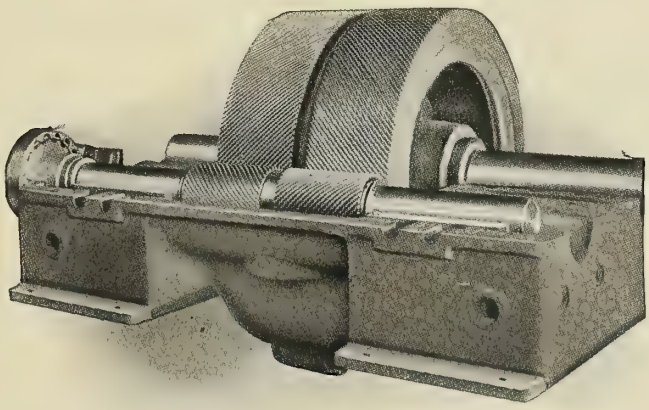
The high speed of steam turbine speed-reducing gears requires absolutely continuous transmission of force from one metallic tooth face to the other. To secure uniform angular movement of both driving and driven parts, and to prevent shock and vibration, the gear teeth must be cut with the utmost precision and the gear and pinion must be so supported that there will be perfect interaction.



4,500 hp. De Laval Marine Reduction Gear.



De Laval Gear and Pinion removed from case; 2,500 hp. capacity.



De Laval Double-helical Speed-reducing Gears with casing cover removed, showing method of holding pinion and gear shafts rigidly in the same plane.

Methods and machines for cutting successful high-speed steam-turbine speed-reducing gears have been designed and perfected by us during the past 25 years, and in De Laval Gears the correct pitch, tooth angle and tooth contour are assured. Hand work upon the teeth is not permitted.

In order to realize the benefits of accurately cut gears, IT IS NECESSARY THAT THE CASING BE SO DESIGNED THAT GEAR AND PINION WILL BE HELD IN ABSOLUTELY CORRECT ALIGNMENT and will be protected from outside forces and distortion. This is accomplished by the correctly designed De Laval rigid gear casing, all parts of which are carefully machined to limit gages.

The correctness of our methods is proved by the many De Laval Gears which are in daily satisfactory operation, and by the fact that we have OVER 75,000 HP. OF GEARS FOR SHIP PROPULSION NOW UNDER CONSTRUCTION.

De Laval Geared Turbines are used both for main drive and for auxiliaries, including large capacity centrifugal condenser circulating pumps, direct-current generators, centrifugal fans and blowers, etc. De Laval boiler feed pumps give maximum and reliability with minimum space requirement. The exhaust steam from turbine-driven auxiliaries can be utilized in direct contact feed heaters, or turned into the main condenser, free from oil.

State service required and ask for Publication No. 46.

DE LAVAL

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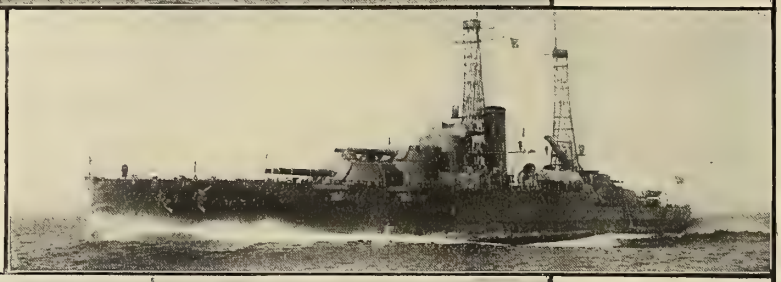

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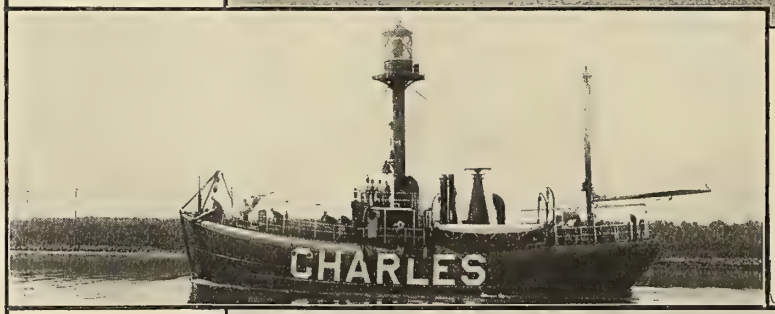

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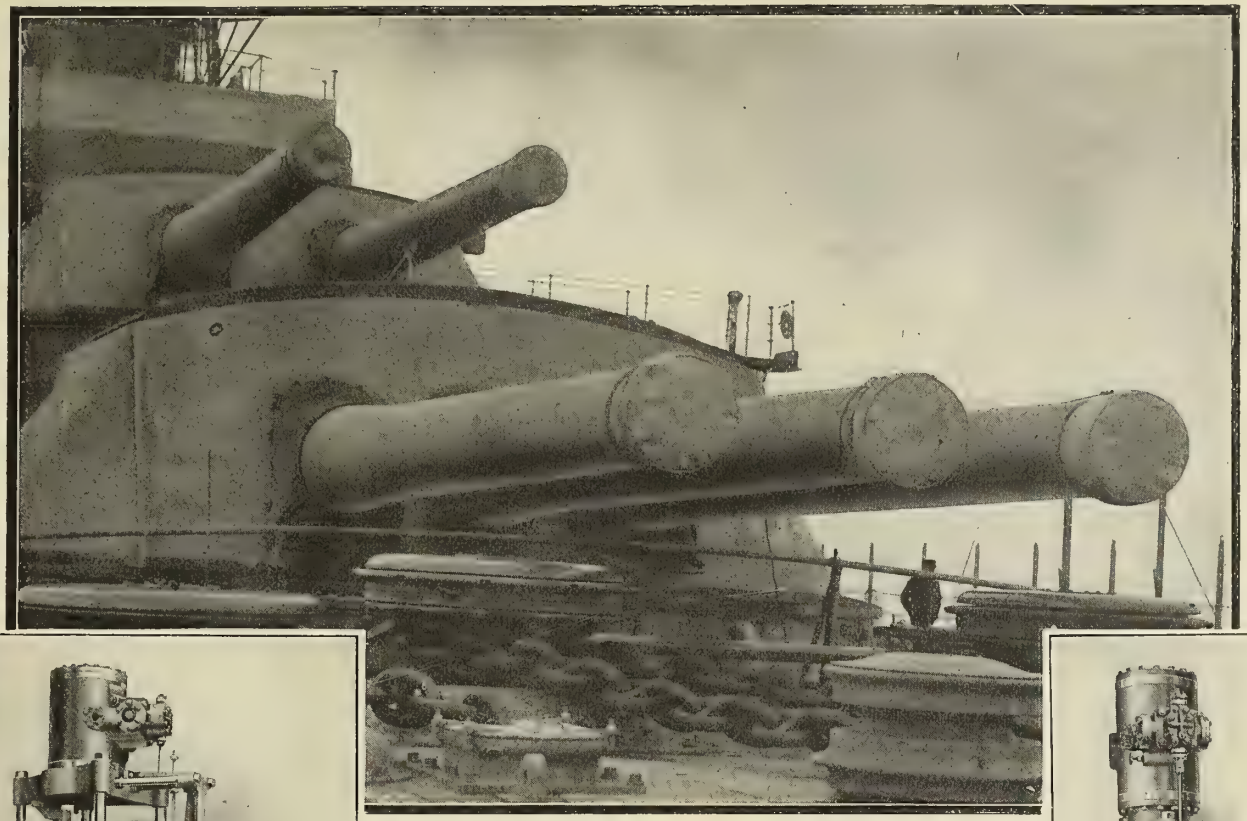

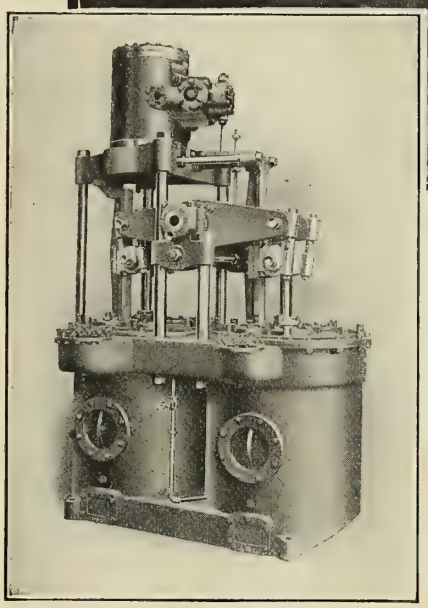

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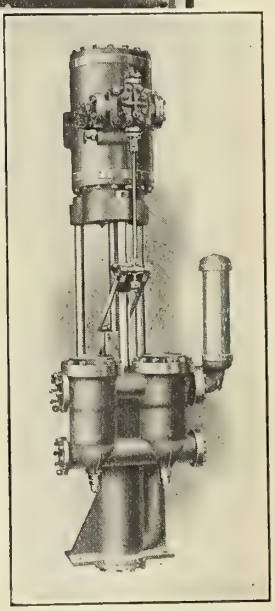

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The "NEVADA" is outfitted exclusively with—

BLAKE PUMPING MACHINERY

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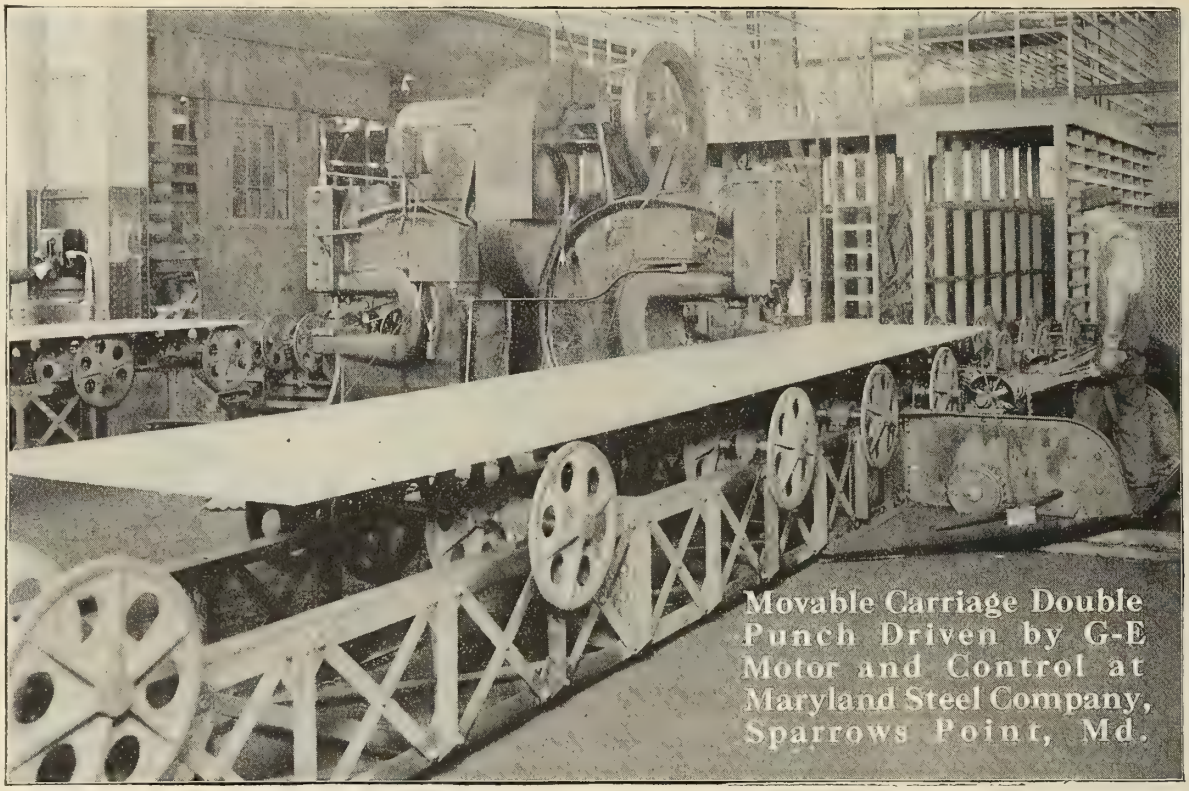

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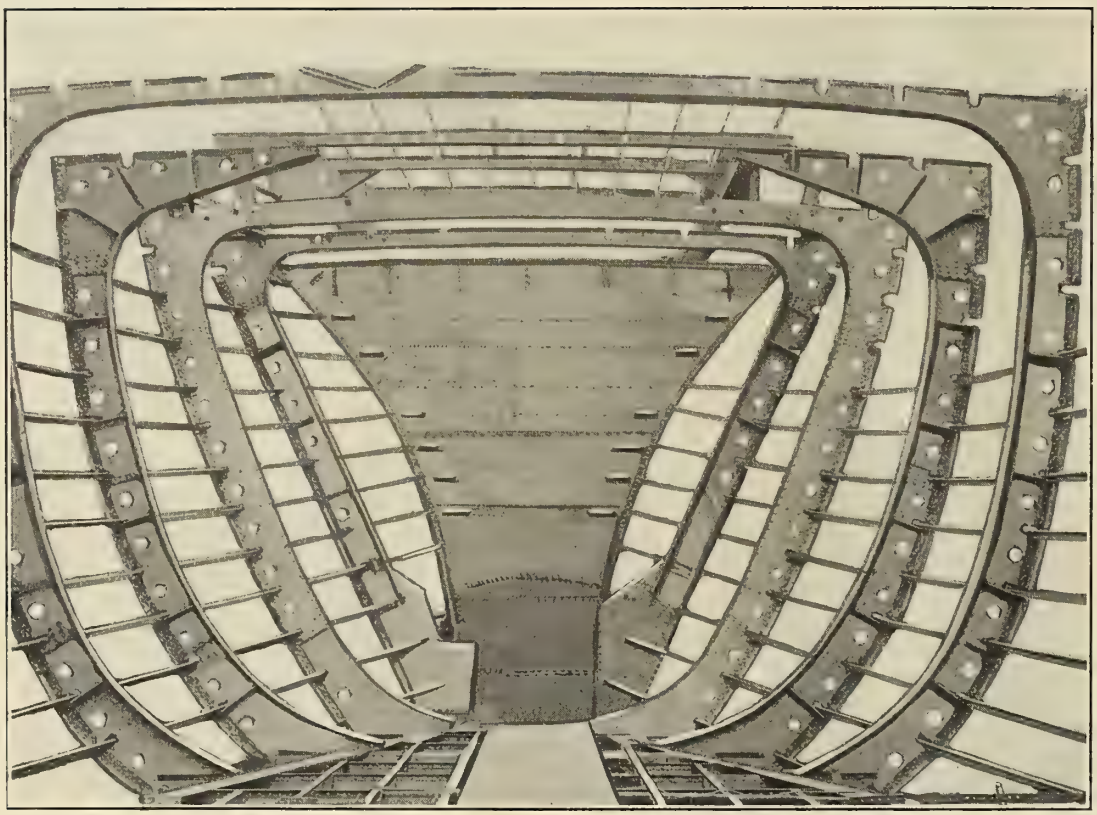

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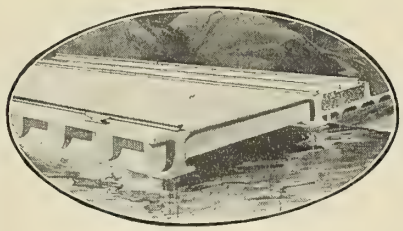
Cleveland Docks



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Cleveland Docks stand, better engineering in dock design.

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Cleveland Docks stay put.

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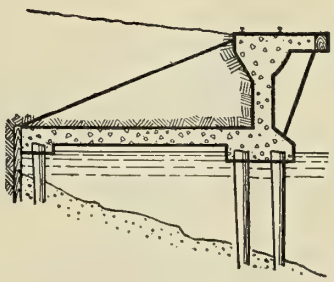
—Forever

Cleveland Docks are permanent structures, rot, rust and fire-proof.

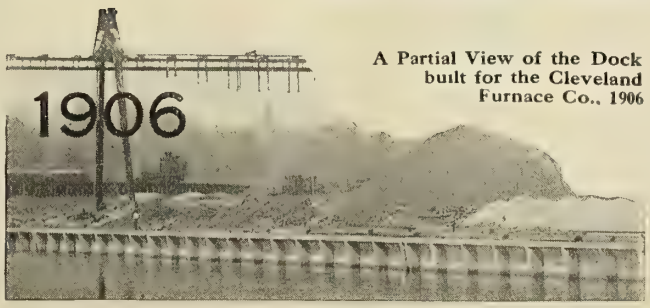


To help meet your dock and pier problems, to secure for you that structure which will best meet your needs, and at a comparable cost, we offer you the engineering services of an organization that has been handling problems of reinforced concrete and dock design for over 20 years.

Our basic designs are covered by a generic patent, well-earned by extended and original work. This patent has been sustained by U. S. District and Circuit Courts, the highest authority in the country. Our engineering counsel and designs have saved clients money and produced for them better structures. We invite you to take up with us any matter of better dock and pier construction.

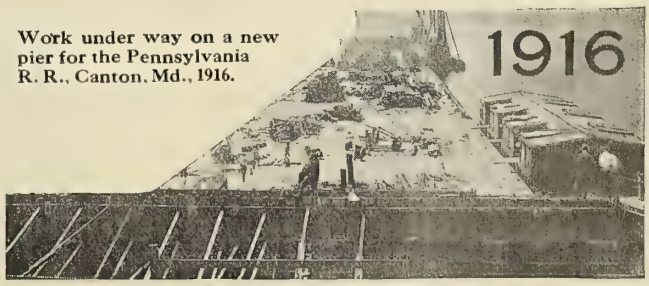
The Cleveland Dock Engineering Co.

General Offices: Citizens Building, Cleveland, Ohio



A Partial View of the Dock built for the Cleveland Furnace Co., 1906

Work under way on a new pier for the Pennsylvania R. R., Canton, Md., 1916.



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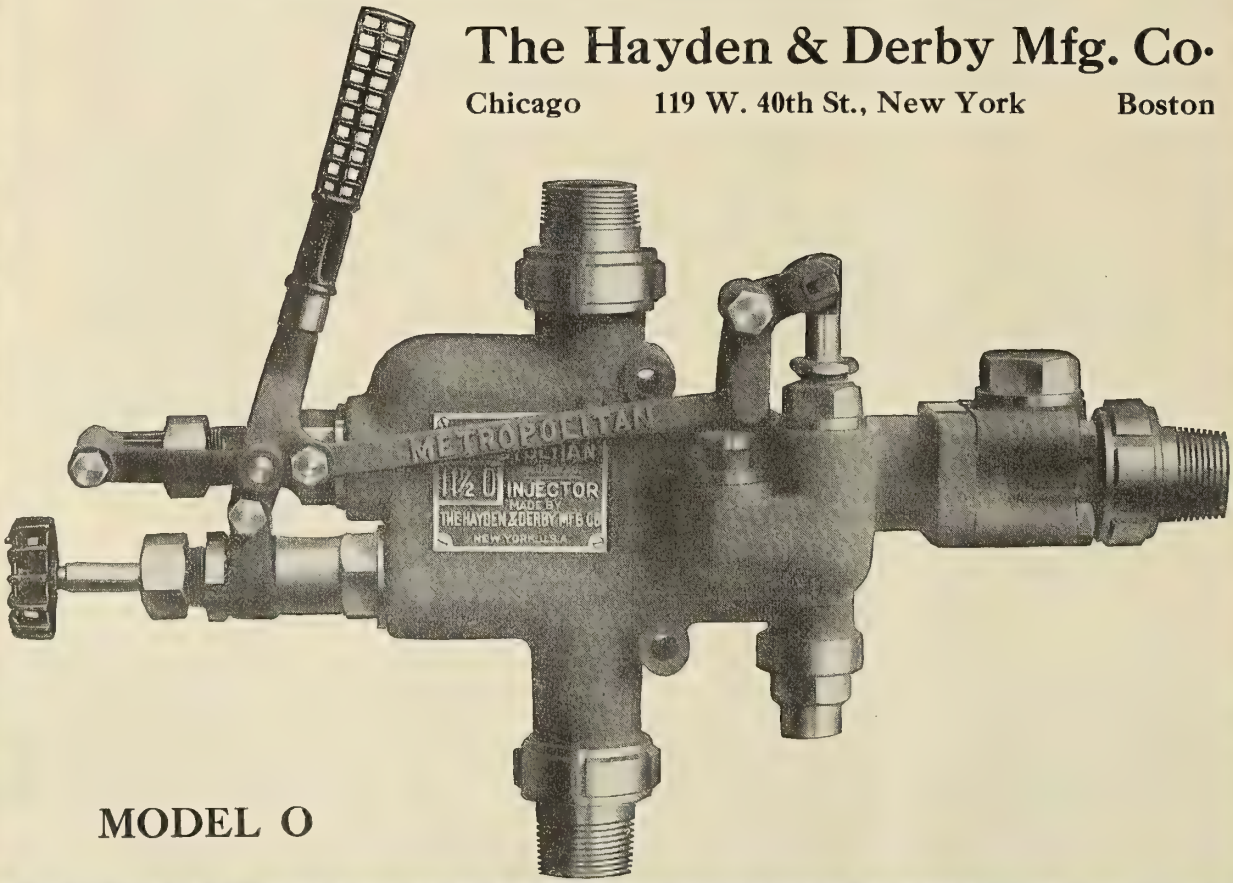

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FOR SHIP-YARD SERVICE

Two 10-Ton SHAW Cranes, span 120 feet, lift 95 feet, over Ship Ways at Fore River Ship Building Corporation. Overhead Electric Traveling Cranes serve the entire area between the runways and reach every part of the ship's construction.

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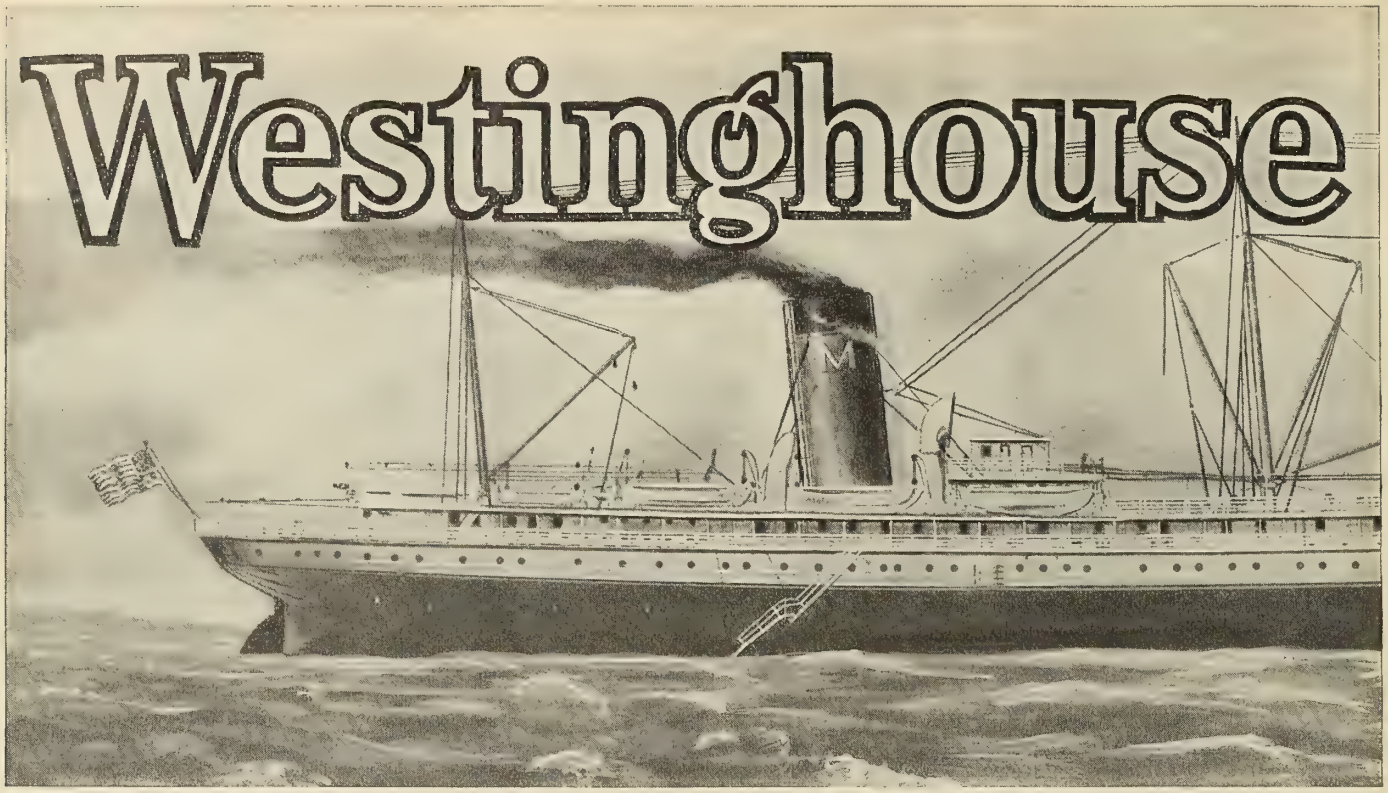

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Passenger and Freighter Service

WESTINGHOUSE W MARINE EQUIPMENT

The highest degree of accuracy in gear cutting, and the self-aligning feature of the flexible pinion frame, enter into the construction of all Westinghouse Marine Gears.

These two features in combination are productive of a Gear of unequalled efficiency and reliability.

The 17,500-ton Passenger and Cargo Steamer "MAUI" of the Matson Navigation Company is shown above as she will appear when completed. This ship will be equipped with two Cross-Compound Geared Propelling Units having a combined capacity of 10,000 shaft horsepower.

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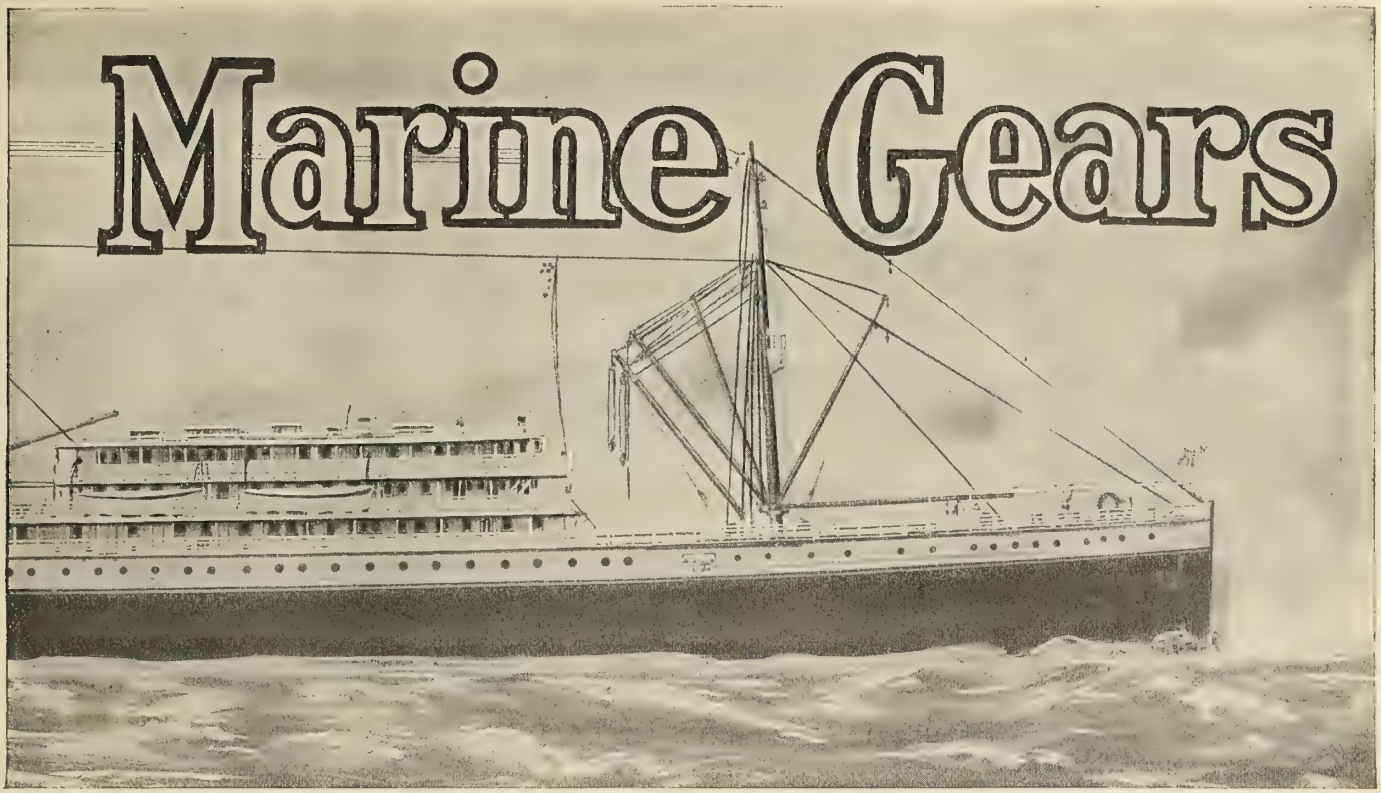

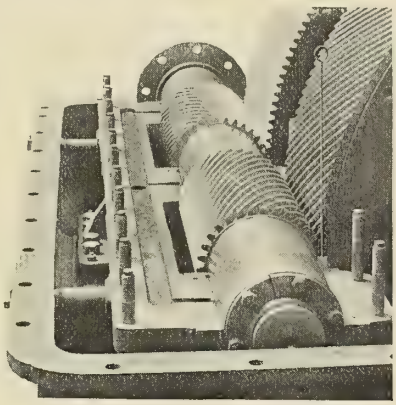

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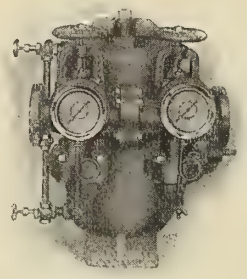

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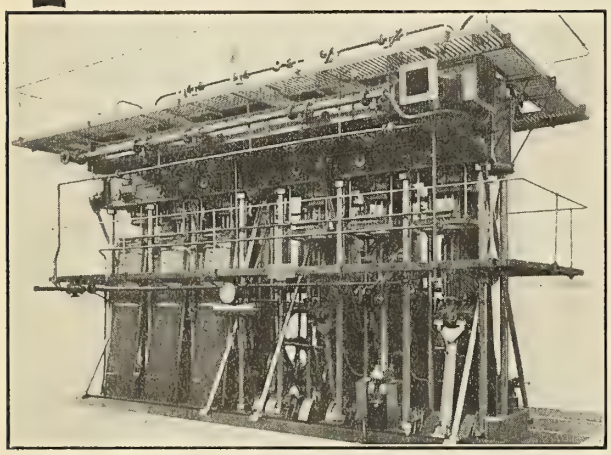

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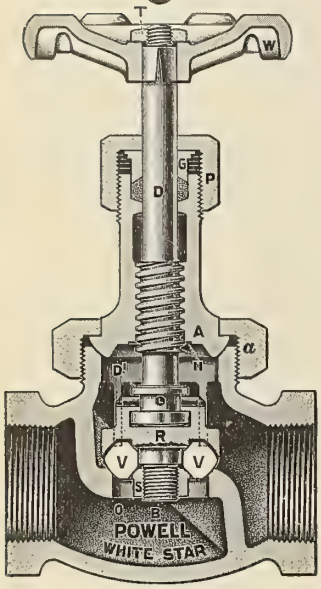

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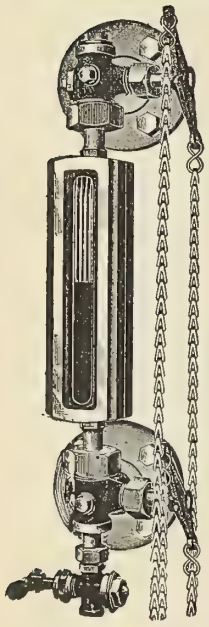

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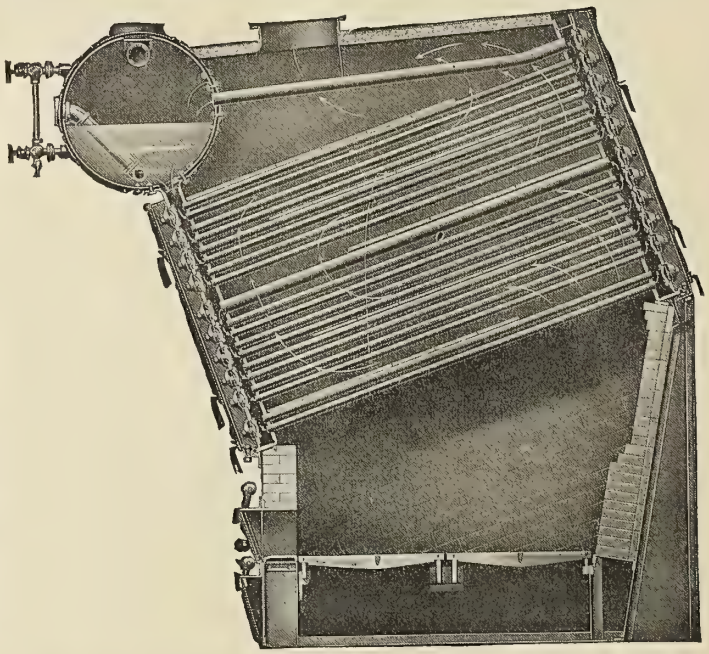

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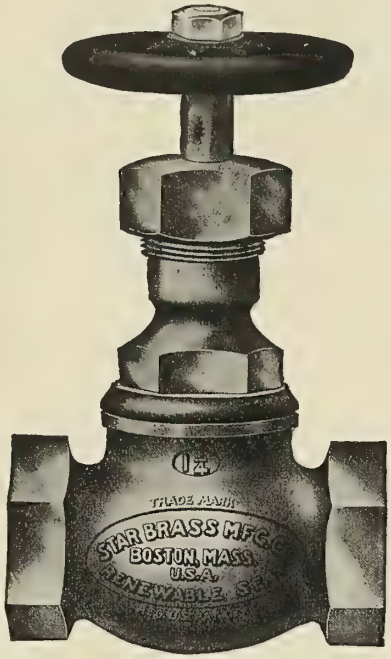

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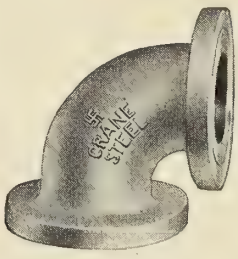

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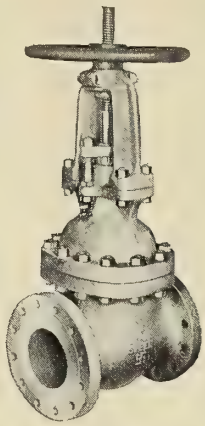
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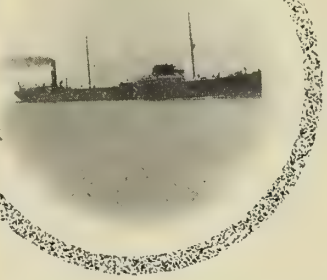

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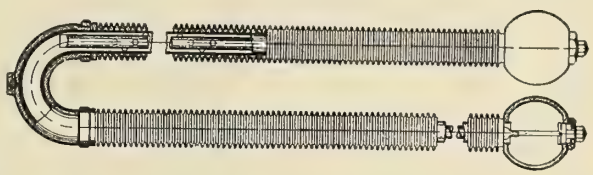

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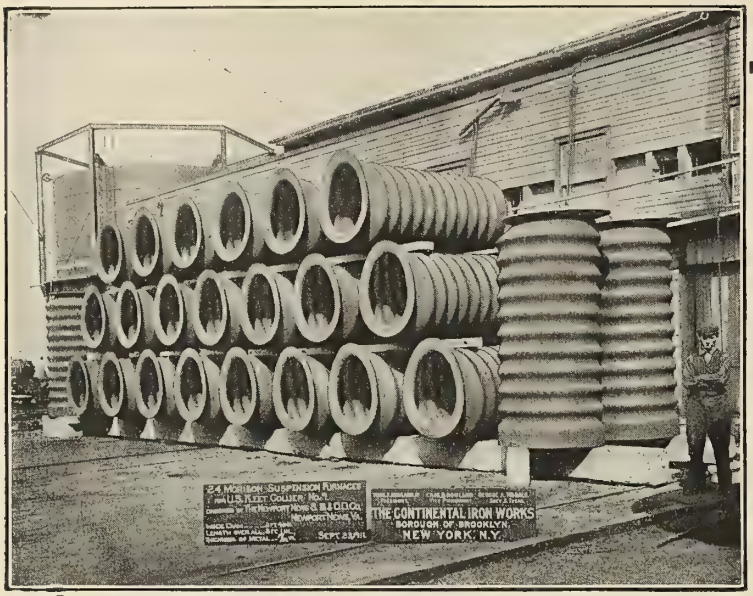

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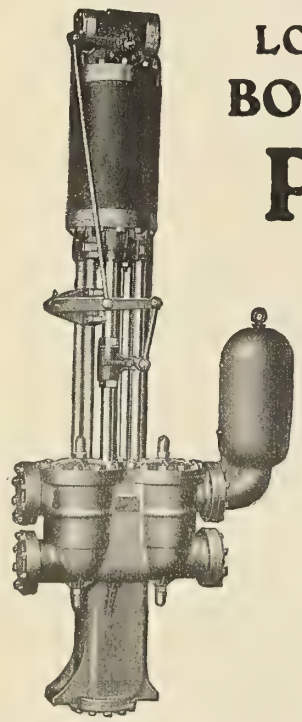

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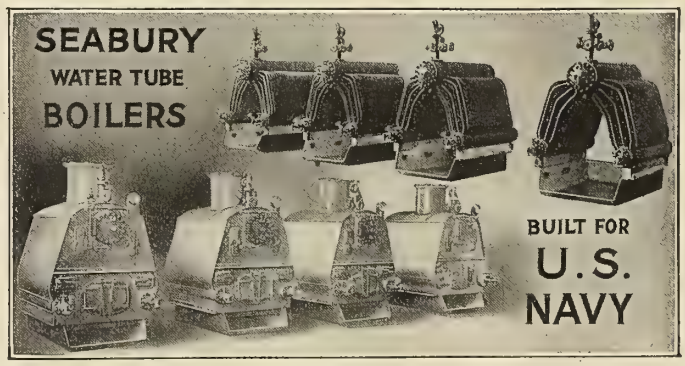

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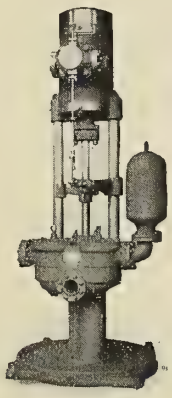

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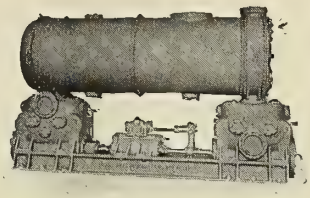

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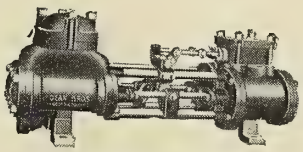

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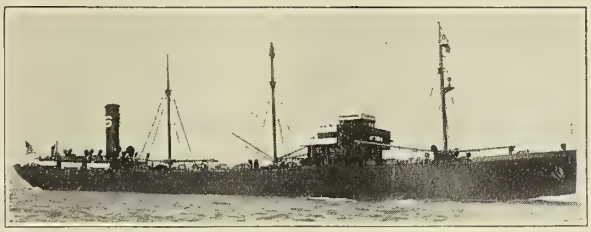

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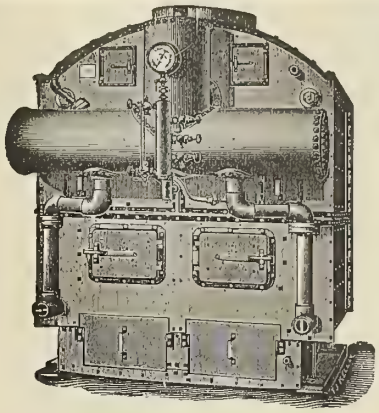

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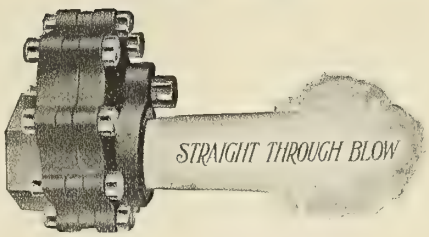

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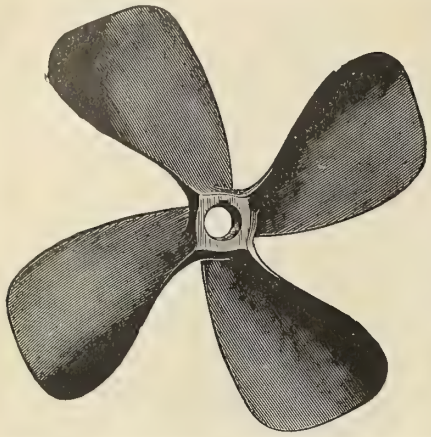

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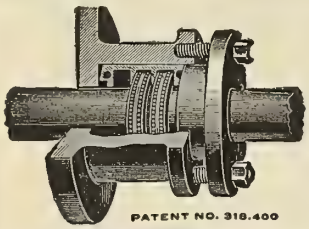

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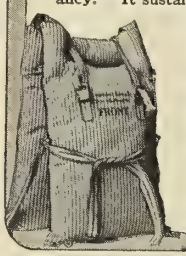

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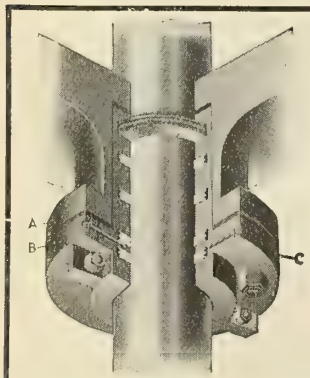

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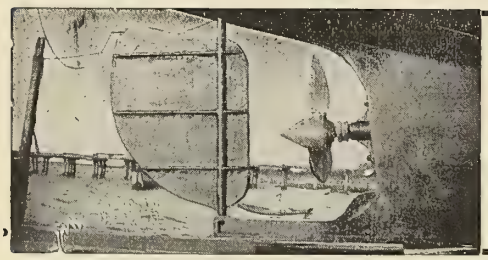
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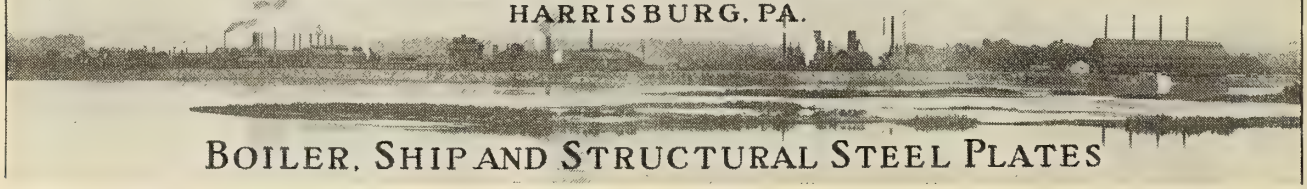

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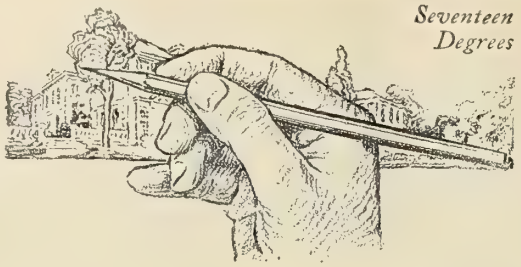

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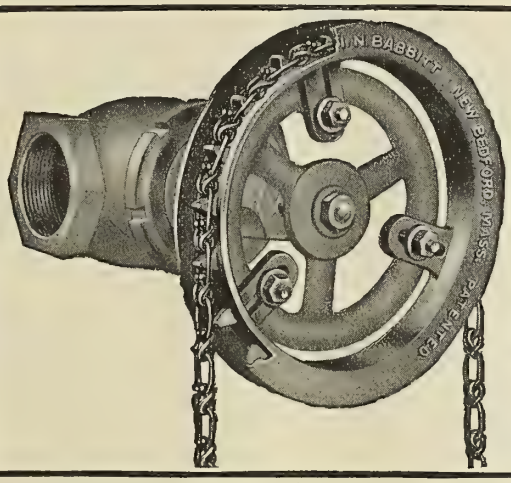

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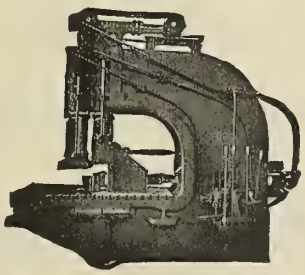

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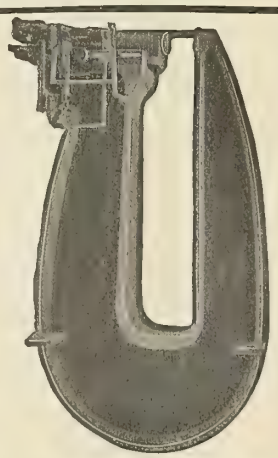

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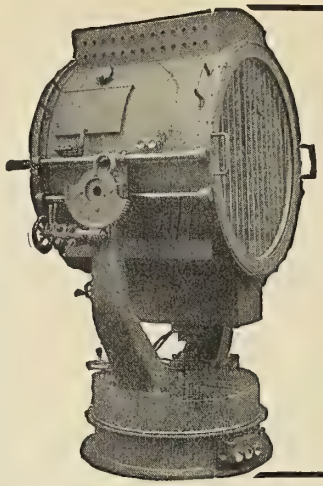

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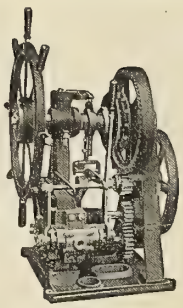

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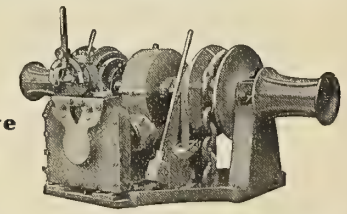

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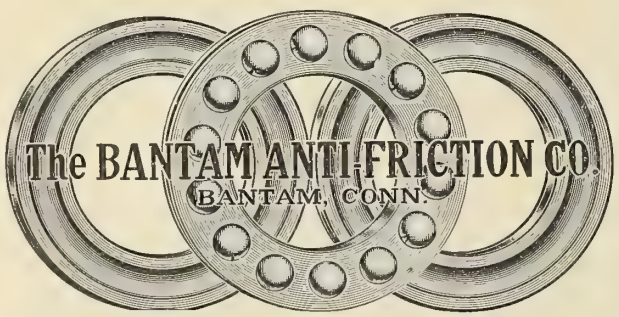

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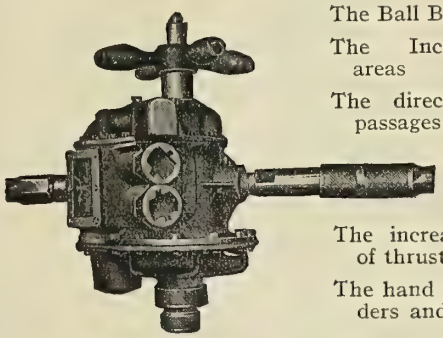

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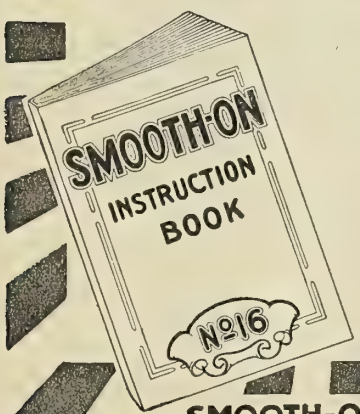

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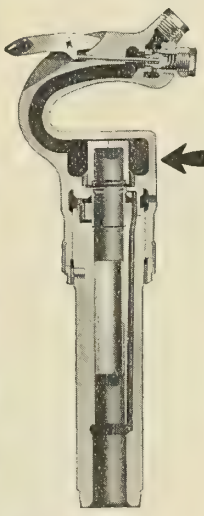

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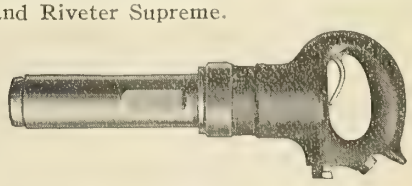

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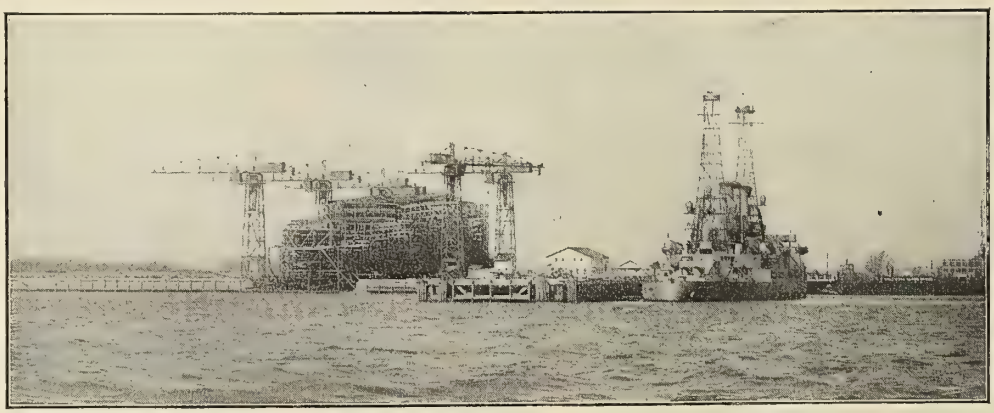

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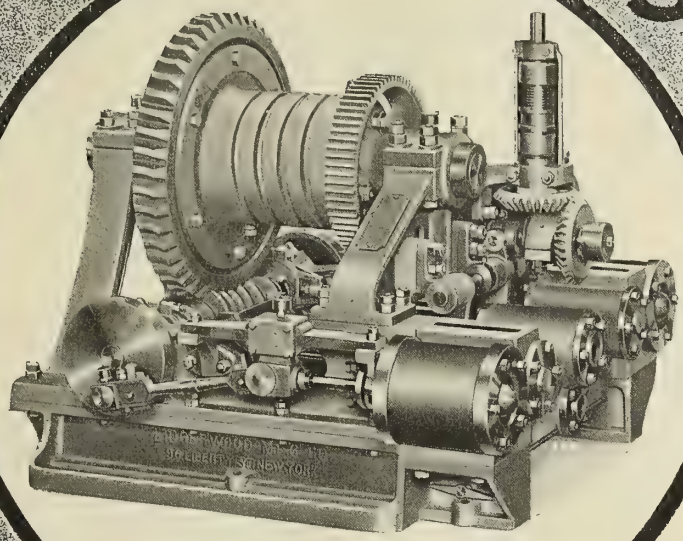

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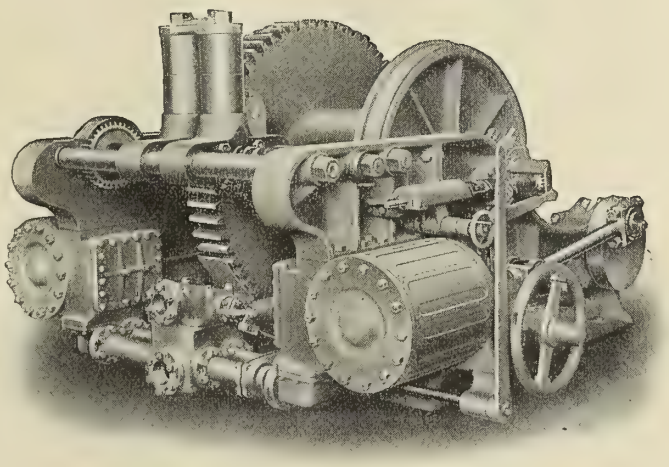

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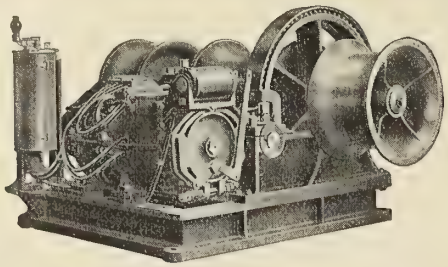

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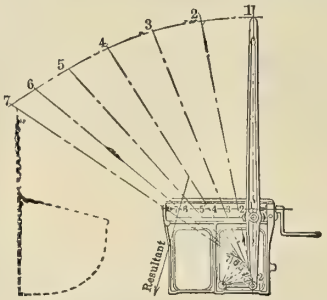

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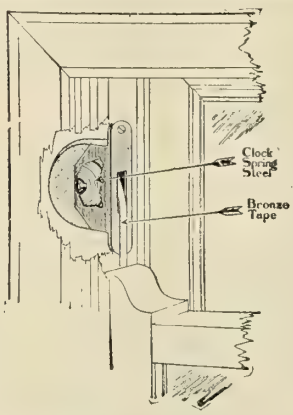

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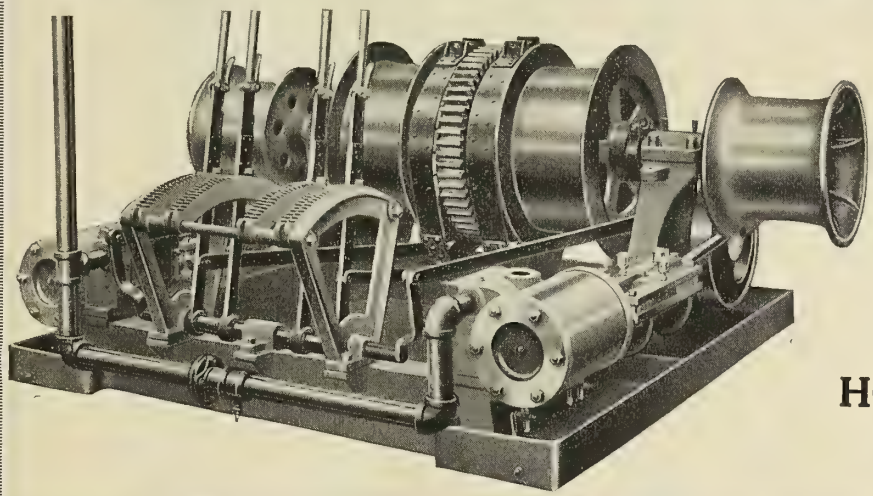

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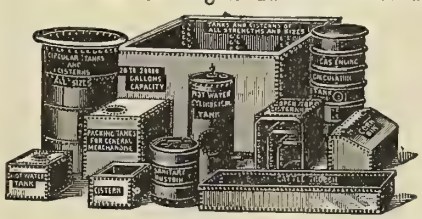

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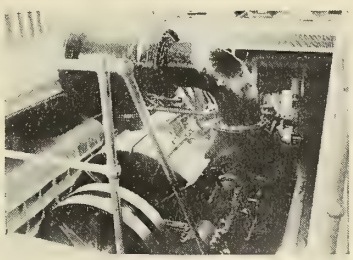

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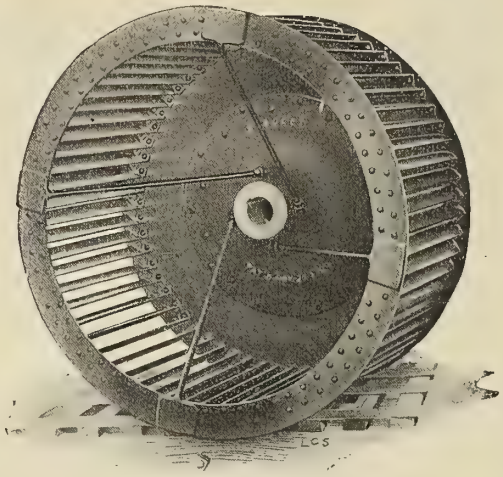

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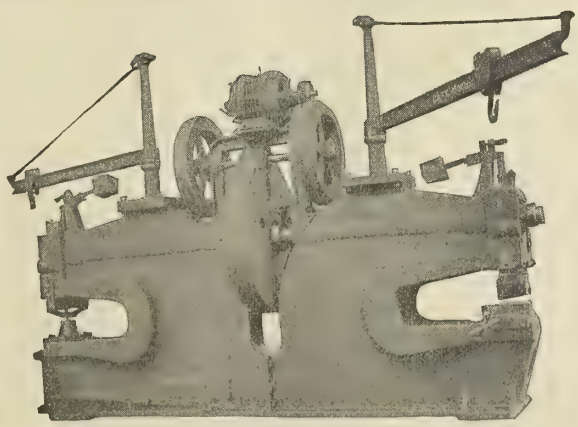

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Towboat for Sale.—85 feet long; 20 feet beam; 140 pounds steam pressure; carries water and coal for 12 hours. Engine 18 by 20; rebuilt 1912; draft, 10 feet loaded.—67-A.

Towboat for Sale.—50 feet long, 12 feet beam, draft about 7 feet, gross tonnage 19, single engine 12 by 24; 70 I. H. P. Upright boiler. Reported in first-class condition and in constant service. Hull wood. Built 1883.—75-A.

Towboat for Sale.—91 feet long, 20 feet beam, 111 gross tons. Built, 1874. Recently rebuilt. Has been kept in thorough repair. Boiler 8 years old. Engine 20 by 26. Steam pressure 125 pounds. Has been used for towing along New England coast.—35-A.

Towboat for Sale.—Built 1902. Length, 72 feet; beam, 19 feet; depth, 8 feet; tanks, 15,000 gallons. Can be easily increased by 5,000. Boiler entirely rebuilt in 1914. Coal bunkers, 16 tons; extra good sea boat. Fire and wrecking pumps installed 1912.—59-A.

Towboat for Sale.—66 feet long; 17 feet beam; 10 feet draft; 45 gross tons; wooden hull. Quarters for 8 men. Simple engine, 17 by 17. Surface condenser, feed water heater, air, circulating, feed and surface pumps. Leg type boiler, 12 feet by 84 inches, allowed 120 pounds. Has steam capstan, electric light, 9-inch projector. Is now used for habor and sea towing.—74-A.

Towboat for Sale.—56 feet long; 15 feet beam; draws 8 feet; wooden hull; 40 gross tons; quarters for 7 men; engine fore-and-aft compound; 12 by 22 by 14. Surface condenser; air, circulating, feed and fire pumps; feed water heater; upright boiler 9 feet by 72 inches, allowed 138 pounds. Speed, 10 miles. Now used in inside harbor work for towing and tending dredges.—73-A.

Towboat with Valuable Contract for Sale.—Wooden hull. Built, 1872 but kept in the best of condition and only recently thoroughly overhauled. 58 feet long; 16 feet beam: 29 gross tons. Single engine, 16 by 16. Machinery reported in excellent condition. Owner sells on account of health and willing to turn over contract for towing worth about $9,000 a year.—76-A.

STEAMERS

River Boat for Sale.—Built 1890; 123 feet long; 22 feet beam engine, 13–26 by 18.—23-A.

Freight Steamer for Sale.—110 feet long. Woodenhull. Built, 1883. Compound engine, 11 by 18 by 12, 120 H.P.—69-B

Freight Steamer for Sale.—Built, 1896. Wooden hull, 90 feet long, 22 feet beam, 89 gross tons. Simple engine, 14 by 16.—46-A.

Freight Steamer for Sale.—92 feet long, 18 feet beam, wooden hull. Built, 1883. Gross tonnage, 74. Single engine, 13 by 14.—47-A.

Freight Steamer for Sale.—103 feet long, 23 feet beam, Wooden hull. Built, 1894. 100 gross tons. Single engine. 14 by 16. 70 H.P.—69-B.

Side Wheel Steamer for Sale.—Built, 1885. Is in excellent condition. Iron hull. 160 feet long. 28 feet beam, 470 tons. Beam engine.—38-A.

Steamer for Sale.—121 feet long, 23 feet beam. Built, 1883; gross tonnage, 220; has 248 horsepower engine; is considered excellent freight carrier for her size.—9-A.

Steamer for Sale.—Built 1898. Is 108 feet long; 23 feet beam; 217 gross tonnage. Handsome steel vessel; very strong. Heavy plates, butt-strapped and double riveted.—69-A.

River Boat for Sale.—134 feet long, 26 feet beam; 228 gross tons; built 1885 of pine; hull reported to be perfectly sound. Has beam engine, return tubular boiler, speed, 10 miles.—22-A.

Steamer for Sale.—Built 1877 but has recently been entirely rebuilt and supplied with new machinery throughout, including boilers. 107 feet long; 22 feet beam; 146 gross tons. Has passenger accommodations.—24-A.

Passenger Steamer for Sale.—Built 1892. 96 feet long; 23 feet beam; 7½ feet deep; 133 gross tons; 78 net tons. Carries 300 passengers and has ample provisions for freight. Galley and sleeping accommodations for a crew of 9.—57-A.

Freight Steamship for Sale.—260 feet long, 39 feet beam. Four decks. Iron hull. 27 staterooms. Gross tonnage, 2,000. Cubic capacity, 120,000 feet. Speed, 12 knots. Scotch boilers. Bunker capacity, 220 tons. Electric light throughout. Steam hoists.—40-A.

Steam Barge for Sale or Charter.—Built of wood, 1913. 105 feet long, 28 feet beam 11 feet depth. Tonnage 250; cargo capacity, 500 tons. Compound engine, 13 by 31 by 22, 250 H.P. Has steam hoists, derricks, etc. Speed, loaded, about six miles.—45-A.

Freight Steamer for Sale.—Iron hull; twin screw; built 1871; rebuilt 1905; thoroughly overhauled 1911; guaranteed in good condition; length, 120 feet; beam, 22 feet; surface condenser; hoisting engine, etc. Gross tonnage, 265; draft, loaded, 7 feet; speed, 8 miles.—64-A.

Steamer for Sale.—Built 1894; has wooden hull; 115 feet long; beam, about 26 feet; 190 gross tons; 500 horsepower; watertube boiler; has accommodations for 350 passengers and good freightroom. Speed, 13 miles. Boat recently inspected, fully equipped; in first class condition.—1-A.

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Freight Steamer for Sale.—Wooden hull. Built, 1896. 90 feet long, 22 feet beam; 89 gross tons. Simple engine, 14-inch cylinder, 16 inch stroke. Return tubular boiler. Reported in first-class order. Hull built of oak and timber reported all sound.—3-A.

Steamer for Sale.—Built 1893: rebuilt, 1914, including new boiler. Gross tonnage, 100; draws 8 feet loaded; speed, 11 miles; has large freight space; is allowed 110 passengers and would be allowed 200 with additional life saving apparatus, has steam heat, electric light, etc.—21-A.

Freight Steamship and Barge for Sale.—Steamship about 1,100 gross tons. 210 feet long, 36 feet beam, 14 feet draft. Built, 1887 of oak; thoroughly rebuilt 1916. Capacity about 1,500 tons deadweight. Carries 1,250,000 feet of lumber. Bunker capacity, 300 tons. Compound engine, 3-furnace Scotch boilers, installed 1915; electric lights, etc. Splendid deck for deck load. Has derricks, winches, etc. Speed about 11 knots. Consumption about 12 tons. The barge is 520 tons gross, 179 feet long, 35 foot beam, built 1889 of oak. Has very large hatches. Will carry about 1,300 tons of cargo or 1,000,000 feet of lumber. Guaranteed in splendid condition. Recently thoroughly rebuilt for ocean service.—4-A.

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Seven Steel Barges for Sale.—Two are 20 by 90 by 6; balance, 24 by 100 by 6.—19-A.

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River Boat for Sale.—Built, 1878. Iron hull. Side wheel passenger and freight steamer. 160 feet long, 28 feet beam. Draws 8 feet. About 575 tons. Horsepower, 800.—37-A.

Dredge for Sale.—80 feet long; 30 feet beam; 10 feet deep; engine, 14 by 22; steam pressure, 85 pounds; spuds, 24 by 24 by 50 feet; yardings, 3; orange peel bucket and extras.—60-A.

Fishing Steamer for Sale.—100 feet long; 18 feet beam; draws about 9 feet. Wooden hull. Vessel completely overhauled recently and steam plant put in first class condition.—72-A.

River Boat for Sale.—Stern wheel river boat; 114 tons net; 100 feet long; 26 feet beam; 18 inches draft light; 5 feet when fully loaded; ample freight accommodations; equipped for 100 passengers.—34-A.

Deck Lighter for Sale.—80 feet long, 32 feet beam, 9 feet deep; deck space 61 by 30 feet; will carry 250 to 300 tons; has boom 55 feet long; will lift 8 tons; has boiler and three drum hoisting engine.—10-A.

Dredge for Sale.—65 feet long; 27 feet wide; 6 feet deep; engine, 12 by 14. Steam pressure, 125 pounds; spuds, 16 by 16 by 40 feet; dipper, 1½ cubic yards. Can be used as clam shell bucket dredge.—61-A.

Two Barges for Sale.—One 170 feet 6 inches; 38 feet beam; 13 feet depth; gross tonnage, 656; cubic feet capacity, 35,000 cubic feet. The other 175 feet long; 36 feet beam; 681 gross tons; 35,000 cubic feet capacity. Built in 1907-1908.—54-A.

Fishing Steamer for Sale.—Built, 1901; 86 feet long; 25 feet beam; draws, 10 feet loaded; has compound engine; 250 horsepower; new watertube boiler; speed 9 miles. Bunker capacity, 20 tons; consumption, 300 pounds per hour.—27-A.

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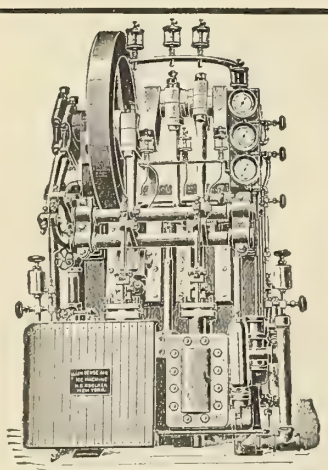

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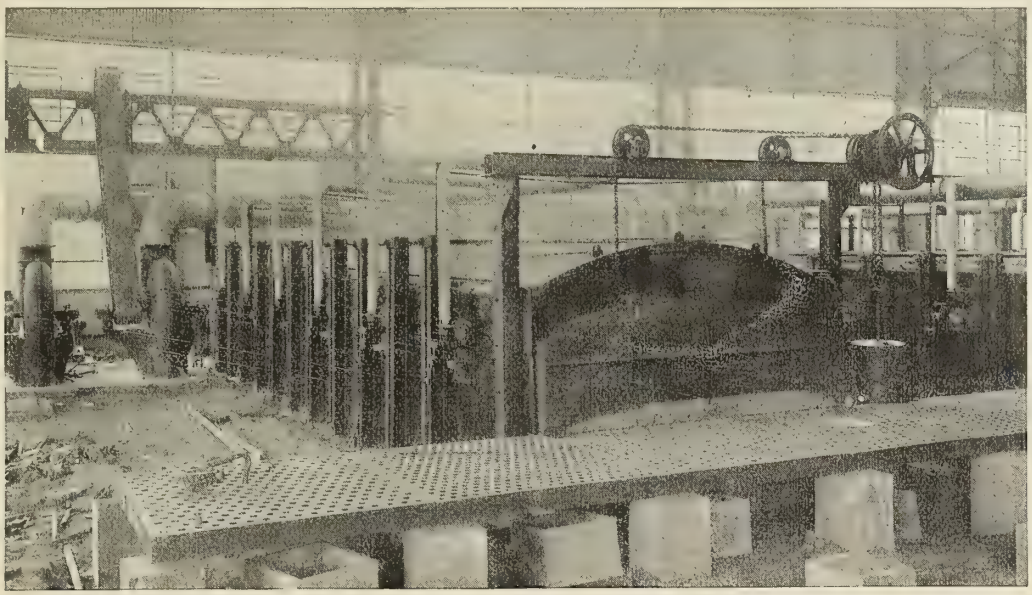

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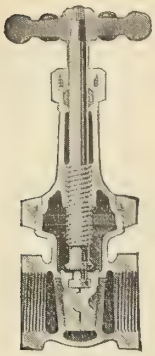

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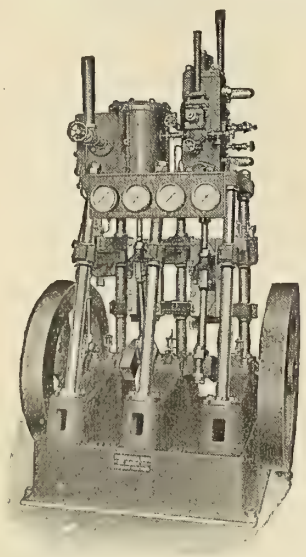

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(See Professional Cards.)

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(See Air Coolers.)

Coolers for Oil.
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(See Brass and Copper.)

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Halzapfels Am. Compositions Co.
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Cotton Duck.
(See Duck.)

Cotton Rubber-Lined Hose.
(See Hose.)

Couch Hammocks.
Bernstein Mfg. Co.
Southern-Rome Co.

Counters.
(See Revolution Counters.)

Covering.
(See Non-Conducting Covering.)

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(Also see Floating Cranes.)
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Brown Hoisting Machinery Co.
McMyler-Interstate Co., The.
Manitowoc Ship Building Co.
Manning, Maxwell & Moore.
Niles-Bement-Pond Co.
Shepard Elec. Crane & Hoist Co.
Welin Marine Equipment Co.

Crank Shafts.
(See Forgings.)

Cutters.
Morse Twist Drill & Machine Co.

Cylinder Boring Bars.
Niles-Bement-Pond Co.

Cylinder Relief Valves.
(See Valves.)

Cylinders for Compressed Air, Gas, Etc.
Continental Iron Works, The.
National Tube Co.

Danbolin for Ships' Holds.
Holzapfels Am. Compositions Co.

Davits.
Steward Davit & Equipment Corp.
Welin Marine Equipment Co.

Davit Turning Gear.
Coston Signal Co.

Deck Hoists.
(See Hoisting Engines.)

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Sands, A. B., & Son Co.
Williams, William E.

Deck Pumps.
(See Pumps.)

Diaphragm Pumps.
(See Pumps.)
Hyde Windlass Co.

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Morse Twist Drill & Machine Co.
Williams, William E.

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(Also see Oil Engines.)
Craig Engine & Machine Works.
New London Ship & Engine Co.
Werkspoor.

Direct-Connected Sets.
(See Electrical Plants.)

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McNab Co., The.
Williams, William E.

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Welin Marine Equipment Co.

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(See Evaporators.)

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Morse, Andrew J., & Son, Inc.

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(See Mechanical Draft.)

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Williams, William E.

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(See Valves.)

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Niles-Bement-Pond Co.

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Morse Twist Drill & Machine Co.
Williams, William E.

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Drills, Pneumatic.
(See Air Drills.)

Drills, Portable.
(See Portable Drills.)

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Drop Hammers.
Chambersburg Engineering Co.
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Baltimore Dry Docks & Shipbuilding Co.
California Shipbuilding Co.
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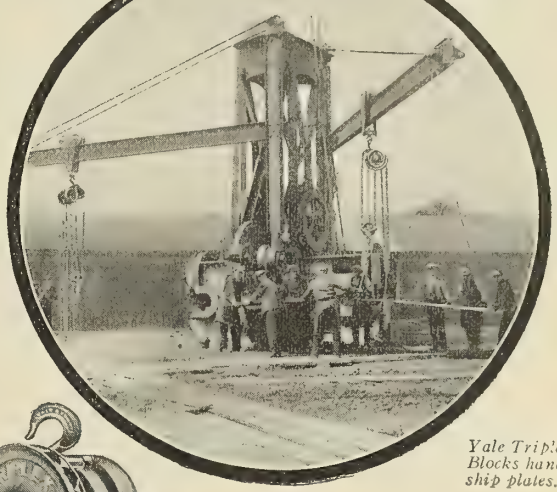

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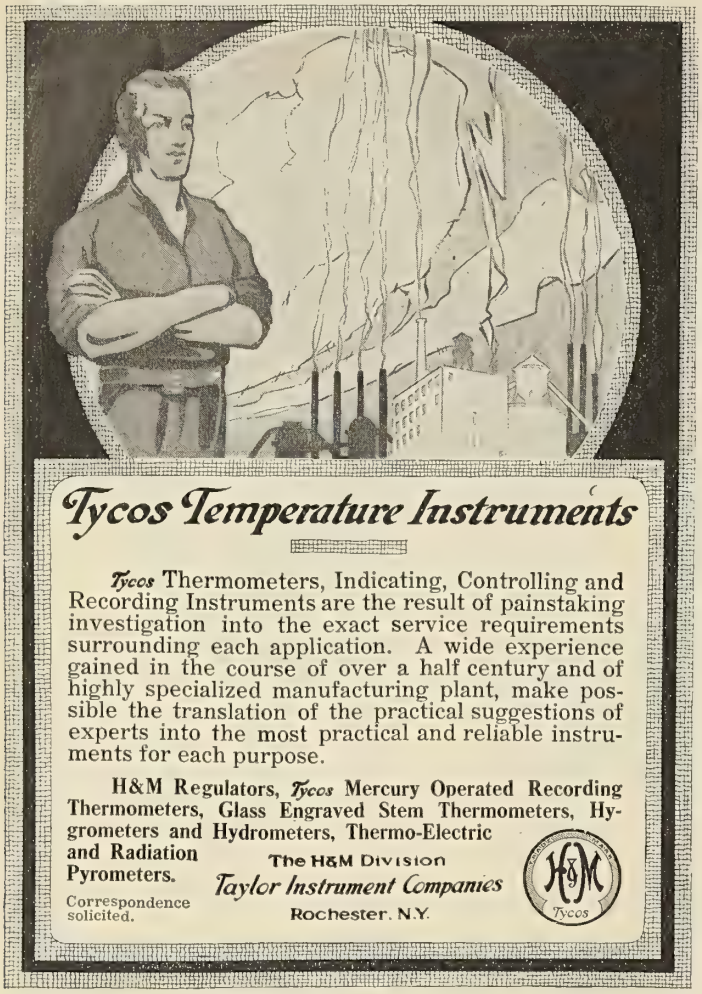

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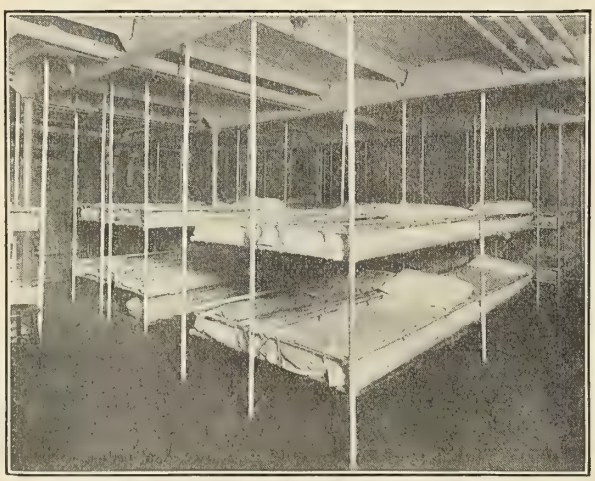

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Independent Pneumatic Tool Co.
Williams, William E.

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(See Freight-Handling.)

Electric Heaters.
General Electric Co.
Williams, William E.

Electric Hoists.
American Engineering Co.
General Electric Co.
Hyde Windlass Co.
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Mead-Morrison Mfg. Co.
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Niles-Bement-Pond Co.
Scully Steel & Iron Co.
Shepard Elec. Crane & Hoist Co.

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Engberg's Electric & Mechanical Works.
General Electric Co.

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General Electric Co.
Weston Electrical Instrument Co.

Engine Logs.
Cummings Ship Instrument Wks.
McNab Co., The.

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(See Packing.)

Engine-Room Clocks.
(See Clocks.)

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(See Steam Specialties.)

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Bowes & Mower.
Cox & Stevens.
Donnelly, W. T.
Farley, Edward P., Co.
Griscom-Russell Co.
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Shepard, Geo. C.
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Watts, J. Murray.
Whittlesey & Whittlesey.
Young, Rakestraw & Ferguson.

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American Blower Co.
American Engineering Co.
Craig Engine & Machine Works, James.
De Laval Steam Turbine Co.
Engberg's Electric & Mechanical Works.
Gas Engine & Power Co. and Chas. L. Seabury & Co.
Hyde Windlass Co.
Kerr Turbine Co.
Mietz Machine Works, August.
New London Ship & Engine Co.
Southwark Fdy. & Machine Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Westinghouse Machine Co.

Engines, Gasoline.
(See Gasoline Engines.)

Engines, Hoisting.
(See Hoisting Engines.)

Engines, Kerosene.
(See Kerosene Engines.)

Engine Oil.
(See Lubricants.)

Engines, Oil.
(Also see Diesel Engines.)
Bolinder's Company.
Craig Engine & Machine Works, James.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
Mietz Machine Works, August.
New London Ship & Engine Co.
Southwark Fdy. & Machine Co.
Standard Motor Construction Co.
Werkspoor.
Wolverine Motor Works.

Engines, Propelling.
Bath Iron Works.
Bolinder's Company.
Craig Engine & Machine Works, James.
Fletcher, W. & A., Co.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
Manitowoc Ship Building Co.
Mietz Machine Works, August.
Moore & Sons Corp., S. L.
New London Ship & Engine Co.
Parsons Mar. Steam Turbine Co.
Sheriffs Mfg. Co.
Southwark Fdy. & Machine Co.
Standard Motor Construction Co.
Trout, H. G., Co.
Ward, Chas., Engineering Works.
Wolverine Motor Works.

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Davidson, M. T., Co.
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Row & Davis, Engineers, Inc.
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Worthington Pump & Mach. Corp.

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Griscom-Russell Co.
Lunkenheimer Co.
National Tube Co.
Williams, William E.

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(See Valves.)

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(See Pumps.)

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Williams, William E.

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(See Dry Docks.)

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(See Boiler Flue Cleaners.)

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(See Boiler Flue Cutters.)

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General Electric Co.
Kerr Turbine Co.
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Terry Steam Turbine Co.
Westinghouse Machine Co.

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Fletcher, W. & A., Co.

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Williams, William E.

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American Steam Gauge & Valve Mfg. Co.
Jerguson Gage & Valve Co.
Lunkenheimer Co.
Powell, Wm., Co.
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Williams Valve Co., D. T.
Williams, William E.

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Williams, William E.

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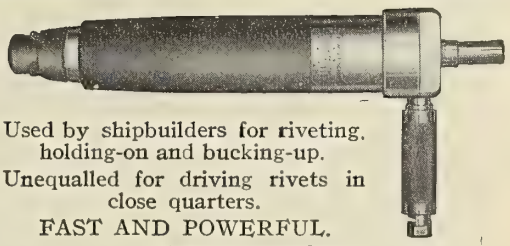

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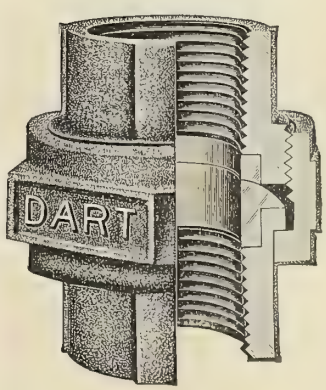

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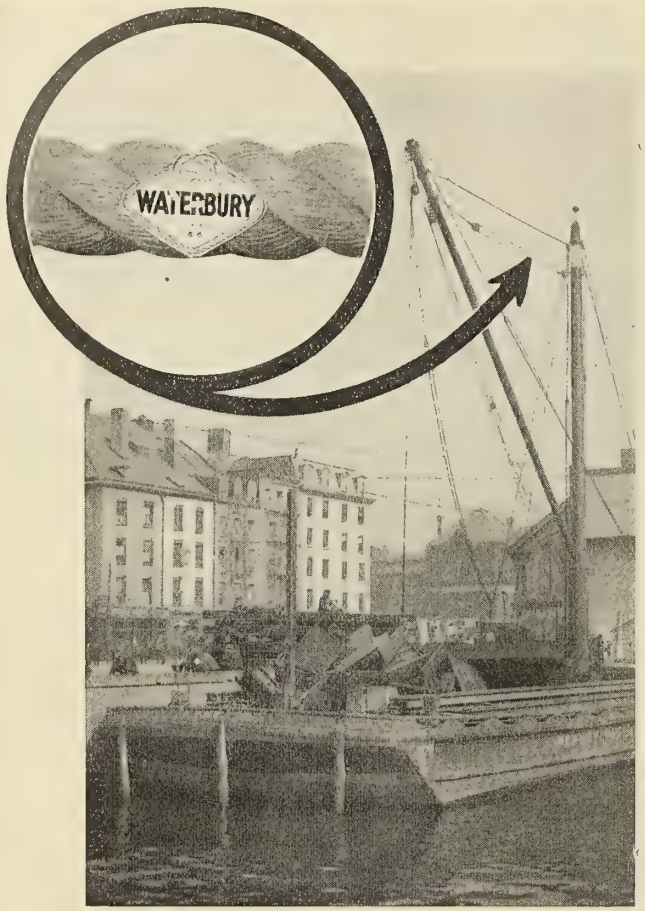

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Sands, A. B., & Son Co.
Williams, William E.

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Williams, William E.

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Welin Marine Equipment Co.
Williams, William E.

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Universal Safety Mattress Co.
Welin Marine Equipment Co.
Williams, William E.

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Ferdinand, L. W., & Co.

Liquid Glue, Waterproof.
Ferdinand, L. W., & Co.

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(See Cranes.)

Log Registers.
Cummings Ship Instrument Wks.
McNab Co., The.
Welin Marine Equipment Co.

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Albany Lubricating Co.
Dixon, Jos., Crucible Co.
Williams, William E.

Lubricating Compound.
Albany Lubricating Co.
Williams, William E.

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Crane Co.
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Lunkenheimer Co.
Powell, Wm., Co.
Schutte & Körting Co.
Williams Valve Co., D. T.
Williams, William E.

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(See Tools, Machine.)

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Hyde Windlass Co.
Lunkenheimer Co.

Manila and Sisal Rope.
(See Rope.)

Marine Cableways.
Lidgerwood Mfg. Co.

Marine Electricians.
(See Electric Plants.)

Marine Engines.
(See Engines, Propelling.)

Marine Engineers.
(See Engineers, Consulting.)

Marine Forgings.
(See Forgings.)

Marine Gas Producers.
Griscom-Russell Co.

Marine Glue.
Ferdinand, L. W., & Co.
Williams, William E.

Marine Hardware.
Ferdinand, L. W., & Co.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol.
Griscom-Russell Co.
Williams, William E.

Marine Heaters.
(See Heating & Ventilating Apparatus.)

Marine Lamps.
(See Lamps.)

Marine Paint.
(Also see Paint.)
Holzapfels Am. Compositions Co.
Toch Bros.

Marine Plumbing.
Mott Iron Works, J. L.
Sands, A. B., & Son Co.
Williams, William E.

Marine Railway Builders.
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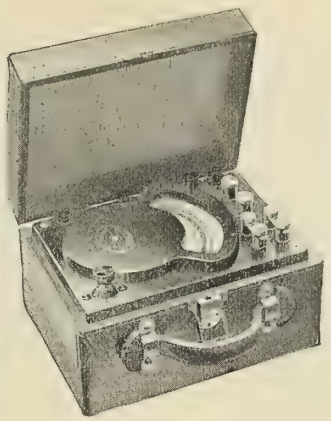

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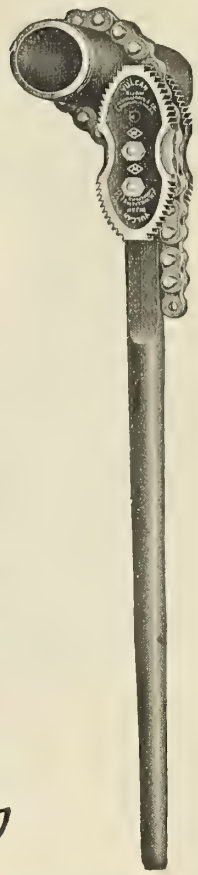

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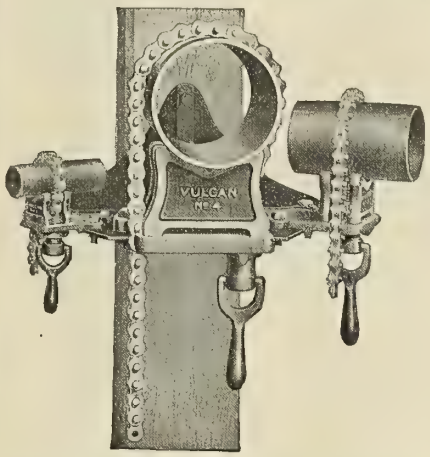

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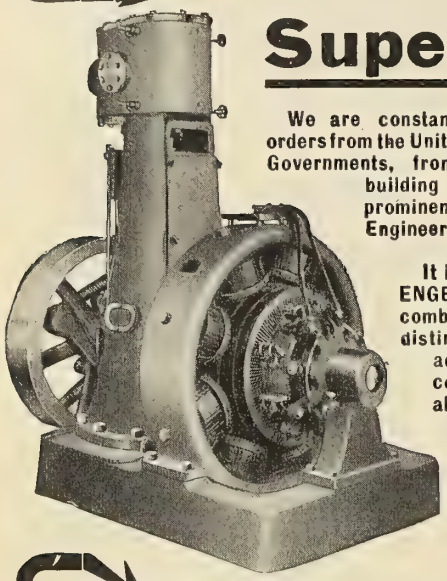

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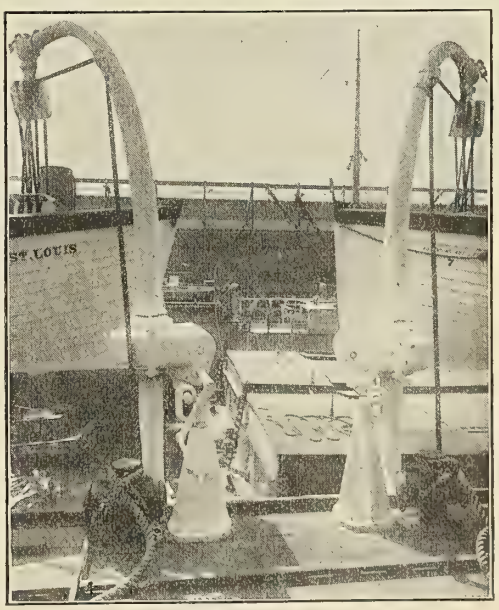

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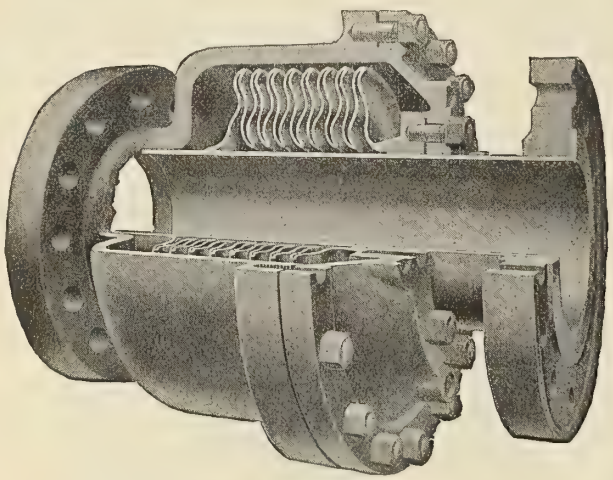

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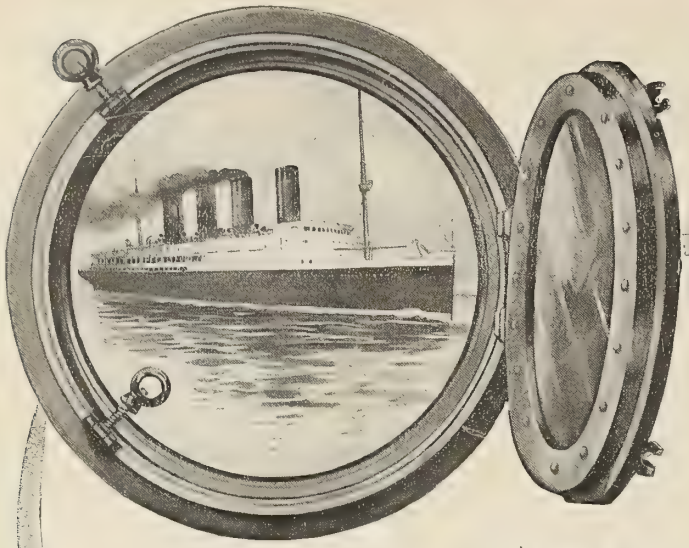

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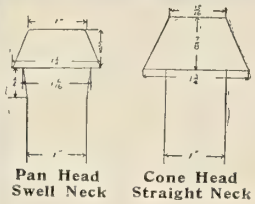

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These rivets are made to fill holes in *punched plates*. The diameter of the punched hole on the *die side* is always slightly larger than the hole on the *punched side*. In other words, the *punched hole* is of *conical shape*.

In assembling, the plates are *reversed*, and by the use of Swell Neck Rivets the holes are completely filled, and the production is increased to a maximum, while the loss occasioned by loose rivets is reduced to a minimum.

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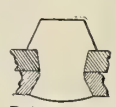
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DECEMBER, 1917

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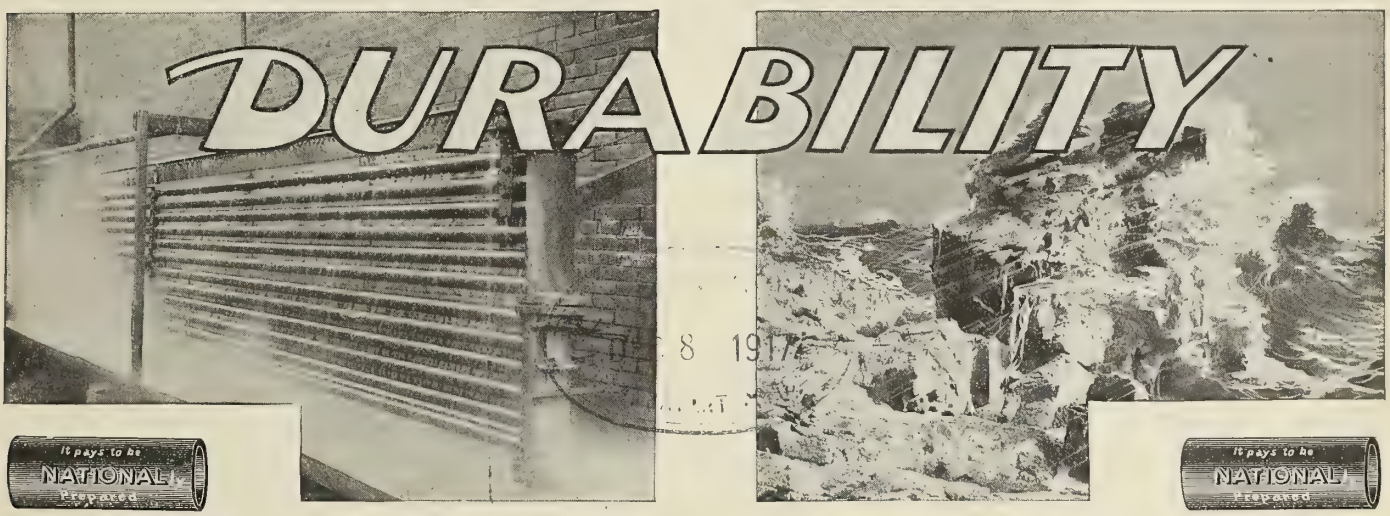

"NATIONAL" PIPE AND NATURE'S ROCKS BOTH EVIDENCE DURABILITY

Mr. N. C. Nicol, Met. Dept.,
National Tube Co.,
Pittsburgh, Pa.

Dear Sir:

In reply to your letter of the 3rd inst., I am sending you photograph of the atmospheric condenser which we have in operation here.

The condenser referred to was installed about five years ago; and is, as you are aware, made up entirely of "NATIONAL" pipe. It has been in operation constantly, night and day, under what I consider most severe corrosive conditions; as it is located on the roof, exposed to the weather with the cooling water constantly trickling over the entire outside of the pipe. During operation the cooling water is heated to a steaming temperature. I mention this, as it is a well known fact that water when heated to high temperature is much more corrosive than when cold.

The name "NATIONAL" which was rolled on each length of pipe, stands out as clearly today as when the pipe was new. From this fact, it is evident that the corrosion has been slight. Also we have not had trouble due to rust-scale forming on outside of pipe, and the only cleaning which we have done is to occasionally brush pipe on the outside with a broom.

As the pipe is subjected to both corrosive action on the outside, which I have mentioned, and also to the action of the condensed steam on the inside, and has withstood this test without any failures, I am glad to give you this letter for reference.

Yours very truly,

(Signed)————————(*)
Chief Engineer.

*Name and Address Supplied Interested Parties on Request

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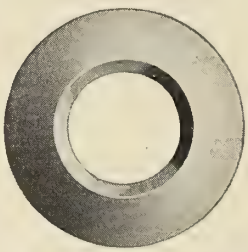

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MARINE ENGINEERING

DECEMBER, 1917

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8 BOUVERIE STREET, E. C.

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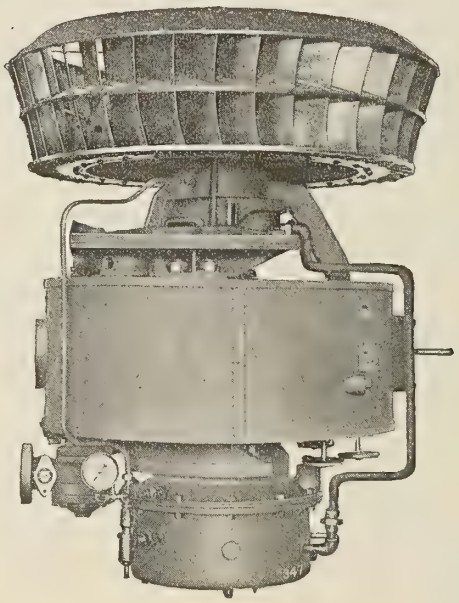

Apart from generator sets the first serious application in the U.S. Navy of the small turbine was forced drafts sets on torpedo boat destroyers. The great importance of the successful and continual operation of this apparatus, made the Government and shipbuilders seriously consider the possibilities of some form of drive that would be more reliable than engines.

Motor drive was impracticable, and **the steam turbine,** therefore, presented the only feasible solution provided a machine could be designed giving a reasonable economy with a mechanical design that would insure absolute reliability.

The economy of turbine drive was demonstated when representatives from the **United States Navy Department** and several of the shipyards visited the works of the **Terry Steam Turbine Co., on June 15, 1909,** and conducted exhaustive tests.

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The features which have caused

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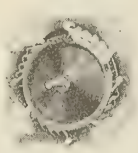
to be used so extensively in the United States Navy have led to its adoption on tugs, river steamers, and ocean going steamships, not only for forced draft but for driving generators and pumps for all services. Those features are economy, reliability, low cost of upkeep and minimum attention.

READ CAPTAIN C. W. DYSON'S ARTICLE, PAGE 545



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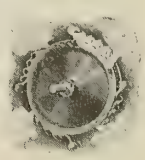

T-496

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¶ Every time a ship heaves-to and waits for a tug to tow her in

¶ Every time a ship lays up to await the arrival of repair parts

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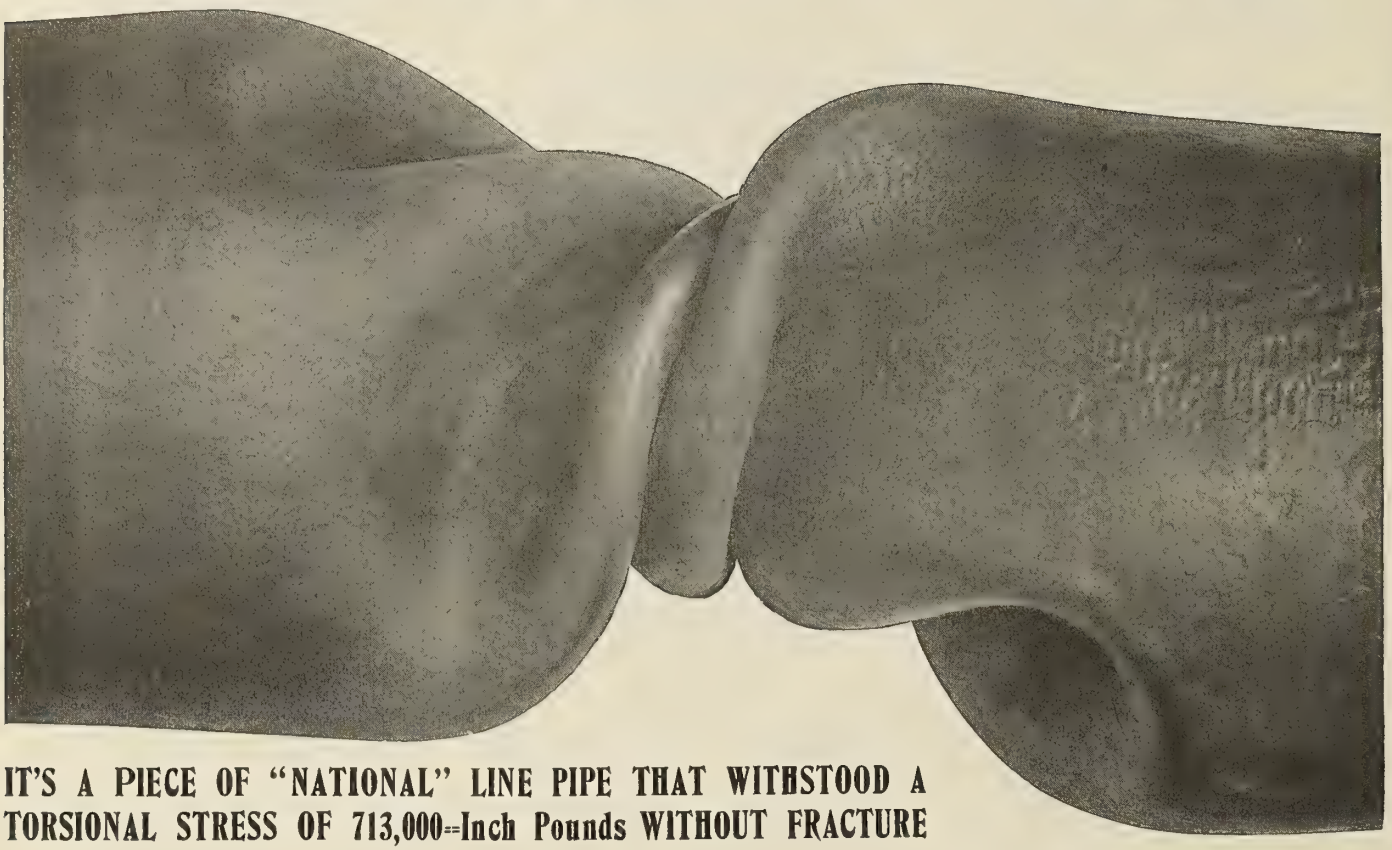

IT'S A PIECE OF "NATIONAL" LINE PIPE THAT WITHSTOOD A TORSIONAL STRESS OF 713,000-Inch Pounds WITHOUT FRACTURE

¶ This shows a piece of 8-inch "NATIONAL" Line pipe subjected to a twisting strain of 713,000-inch pounds. In appearance this looks almost like a piece of rubber, but when it is remembered that this pipe has a thickness of about one-third of an inch and weighs about twenty-nine pounds per foot, the enormous twisting strain can be appreciated. No sign of fracture appears in the material.

¶ This is only one of many experiences wherein the wonderful ductility of "NATIONAL" Pipe has been demonstrated, showing the remarkable quality of the material.

¶To readily identify "NATIONAL" material and as protection to manufacturer and consumer alike, the practice of National Tube Company is to roll in raised letters of good size on each few feet of every length of welded pipe the name "NATIONAL" (except on the smaller butt-weld sizes, on which this is not mechanically feasible on these smaller butt-weld sizes the name "NATIONAL" appears on the metal tag attached to each bundle of pipe)

¶When writing specifications or ordering tubular goods, always specify "NATIONAL" pipe, and identify as indicated.

¶In addition, all sizes of "NATIONAL" welded pipe four in. and under are subjected to a roll-knobbling process known as Spellerizing to lessen the tendency to corrosion, especially in the form of pitting. This Spellerizing process is peculiar to "NATIONAL" pipe, to which process National Tube Company has exclusive rights.

¶"NATIONAL" pipe was awarded the GRAND PRIZE (highest possible award) at Panama Pacific International Exposition, 1915.

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Name Rolled in Raised Letters on National Tube Company Pipe

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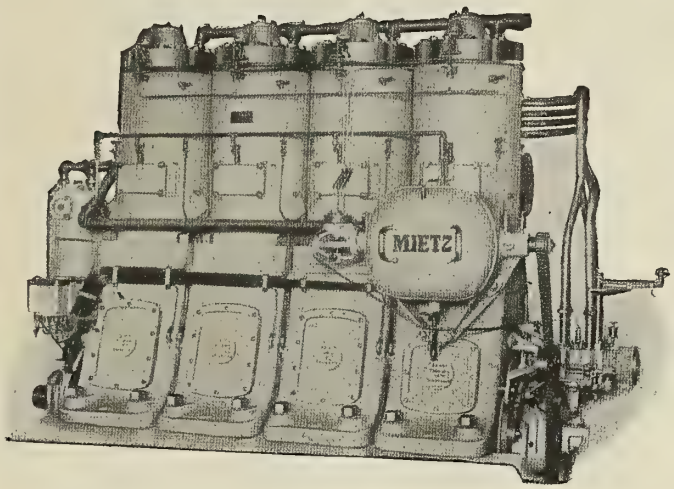

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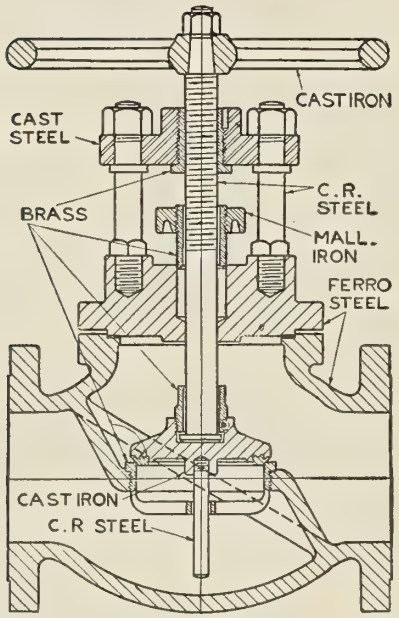

No. 26E

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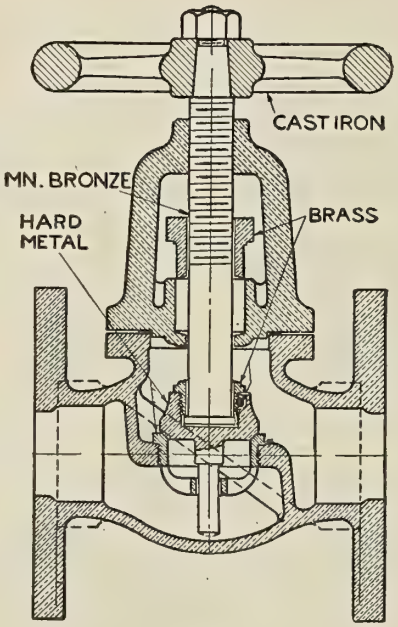

No. 87E

All Brass Bolted Yoke

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Surface Blows;
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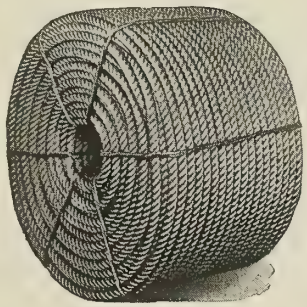

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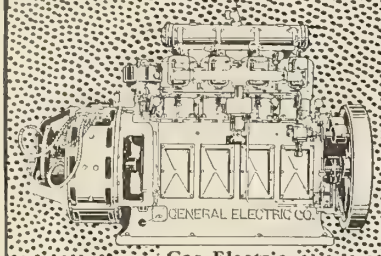
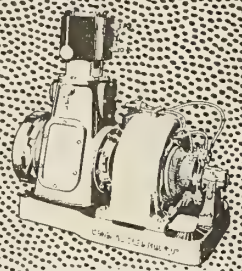
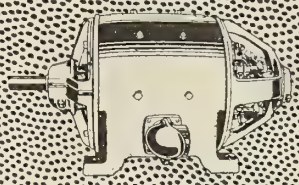
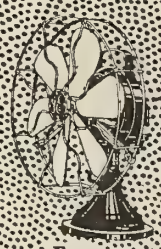


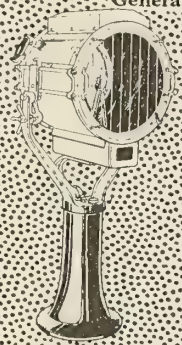
Gas Electric Generator

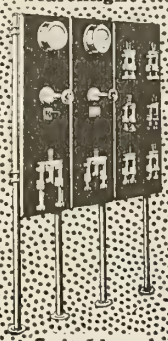

Steam Generating Set


Motor

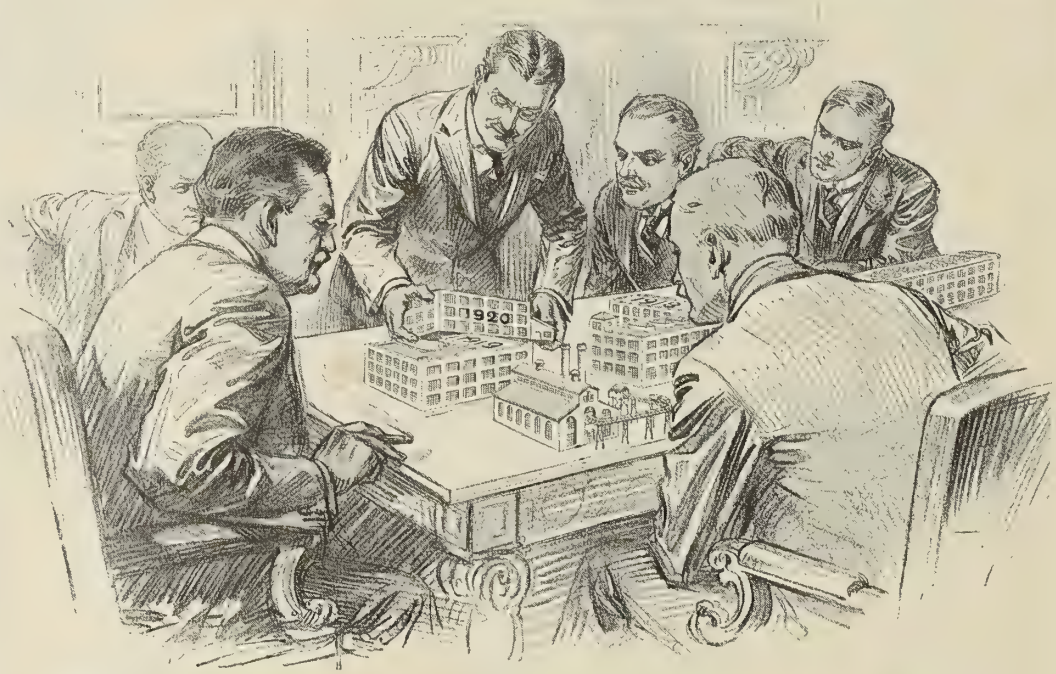
Marine Arc Lamp


Fan


Searchlight


Switchboard

Mazda Lamp



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One 150 KW. set, consisting of one 150 KW. Allis Chalmers generator, type A, class I, 250 volts, 250 amps., compound wound, serial No. 82596, dir. com. on common base to one 225 HP. Allis Chalmers induction motor, type A, class I, 3 ph., 60 cy., 440 volts, 268 amps., 1150 RPM., serial No. 82593, complete with switchboard panels.
One 75 KW. set, consisting of one 75 KW. General Electric type CL generator, 120 volts, 6 pole connected by flexible coupling to one 100 HP. Burke motor, 3 ph., 60 cy., 2300 volts, 900 RPM.

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One 35 KW. set consisting of one 35 KW. Allis Chalmers-Bullock generator, 120 volts, coupled to 50 HP. Westinghouse type C motor, 850 RPM.
One 35 KW. set consisting of one 35 KW. Allis Chalmers generator, 116 to 120 volts, 4 pole, compound wound, dir. connected on common base with 50 HP. Allis Chalmers motor, 2300 volts, 850 RPM.
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Two Maine electric hoists, 2 drums, 7″ flanges, 32″ between flanges, 5 operating levers, ratchets, operating lever, etc., direct connected to 75 HP. Maine slip ring motors, 220 volts, 3 phase, 60 cycle, 865 RPM.
Two Williamson electric hoists, 2 drums, 2 speed, drums 17″ diam. x 32″ face, 4½″ flanges, dir. conn. to 75 HP. General Electric induction motors, ITC, form M, 60 cycle
Eight Flory electric hoists, 2 drum, 2 speed, drums 16″ diam. x 30″ between flanges x 11″ flanges, with six operating levers, direct connected to 75 HP. General Electric slip ring motors 60 cycle.
One Maine electric hoist, 3 drum, one drum 18″ x 32½″ face with 7″ flange, two drums 14″ x 32″ face, 9″ flanges, driven by 75 HP. Main 60 cycle slip ring motor, 220 volts, 865 RPM.
Two Maine electric hoists, 2 drum, drums 18″ x 32″ face, 7″ flanges, driven by General Electric type M motors, 75 HP., 3 phase, 60 cycle, 220 volts, 900 RPM.
Two Meade Morrison electric hoists, 2 drums, drum 30″ x 24″ face, 3″ flanges, with 40 HP. Westinghouse variable speed motors, 500 volts direct current.
Two Lambert, electric hoists, 2 drums, drums 16″ x 18″ face, 5½″ flanges, direct geared to 37 HP. General Electric ITC motors, 3 phase, 60 cycle, 220 volts, 1200 RPM
Three Lidgerwood single drum mine hoists, drums 30″ diam. x 24″ face, 4″ flanges, gear ratio 18:126, geared to Westinghouse type 10-K motors, series wound, with R-32 controllers and grid resistances. Two motors 220 volts, 525 RPM., one motor 550 volts, 878 RPM.
Two Lidgerwood single drum electric mine hoists, drums 30″ x 24″ face, 4″ flanges, direct geared to General Electric form M slip ring motors type IQC, 2 phase, 60 cycle, 220 volts, 830 RPM., complete with T-10 controller.
Five Lidgerwood single drum electric mine hoists, drums 30″ diam. x 24″ face, 4″ flanges, direct geared to Westinghouse motors type 10-K, series wound, 52 HP., 220 volts direct current, 700 RPM., complete with R-32 controllers and grid resistances.

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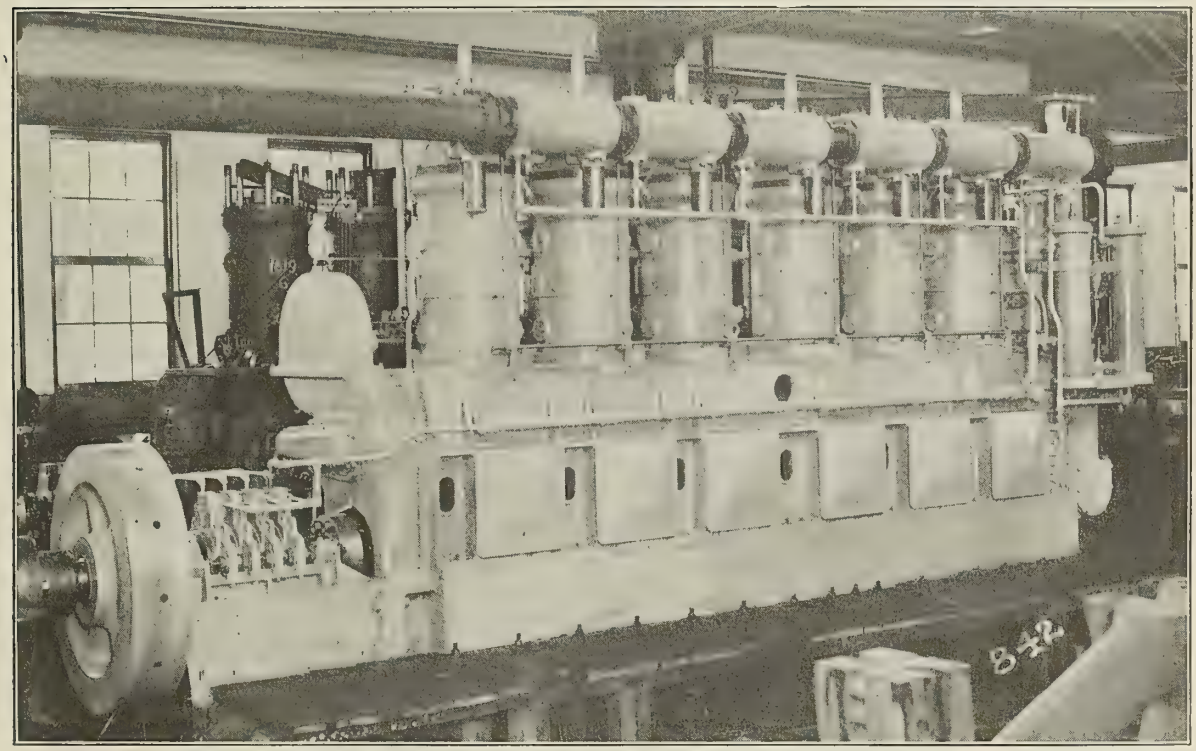

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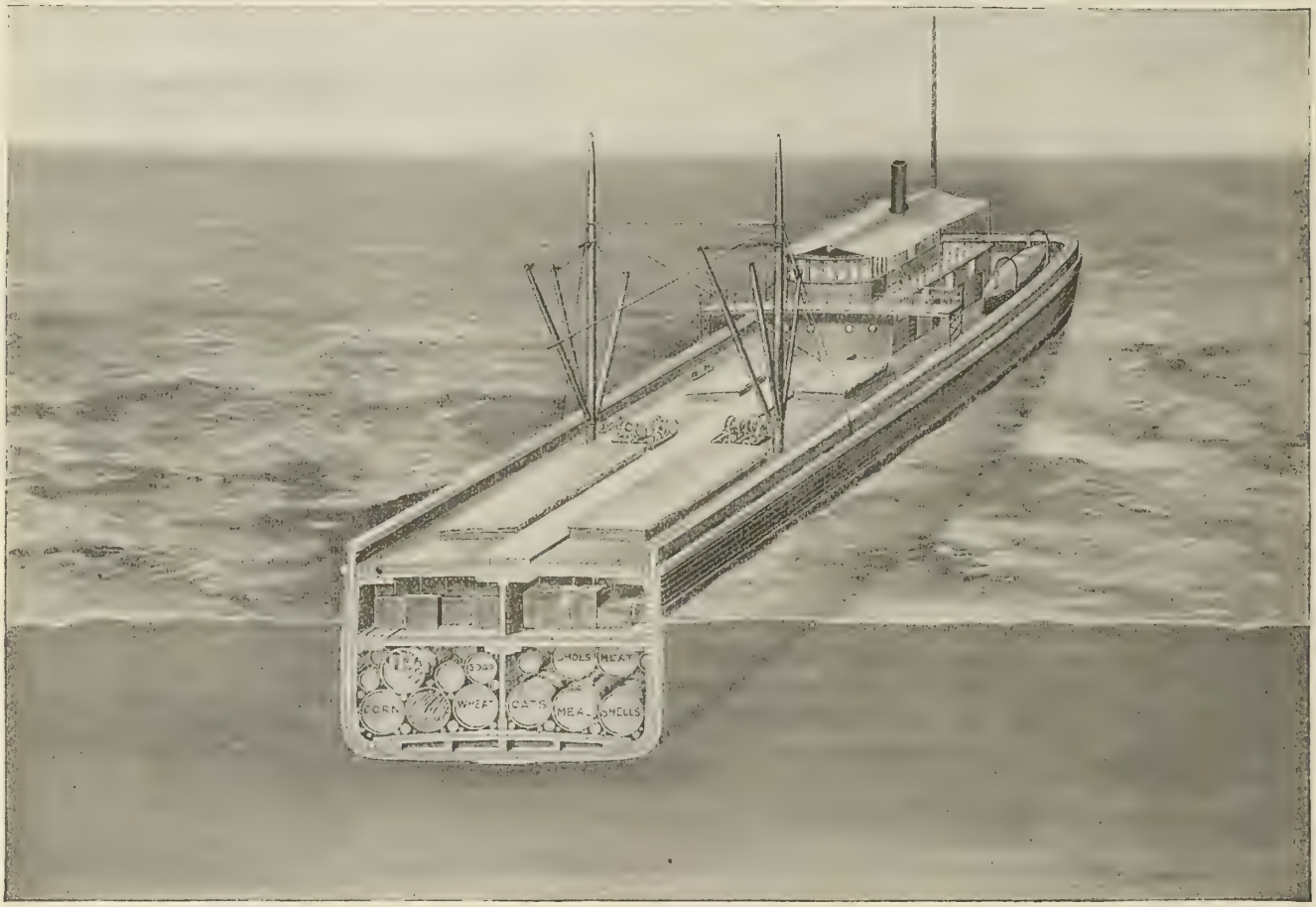

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All material from regular mill stock sizes, excessive lengths not required, all framing, including sides, bottom and bilges, also all planking and other Timbers are of uniform section, insuring least waste material and minimum amount of labor in construction. All parts can be manufactured by machinery in mill ready for assembly.

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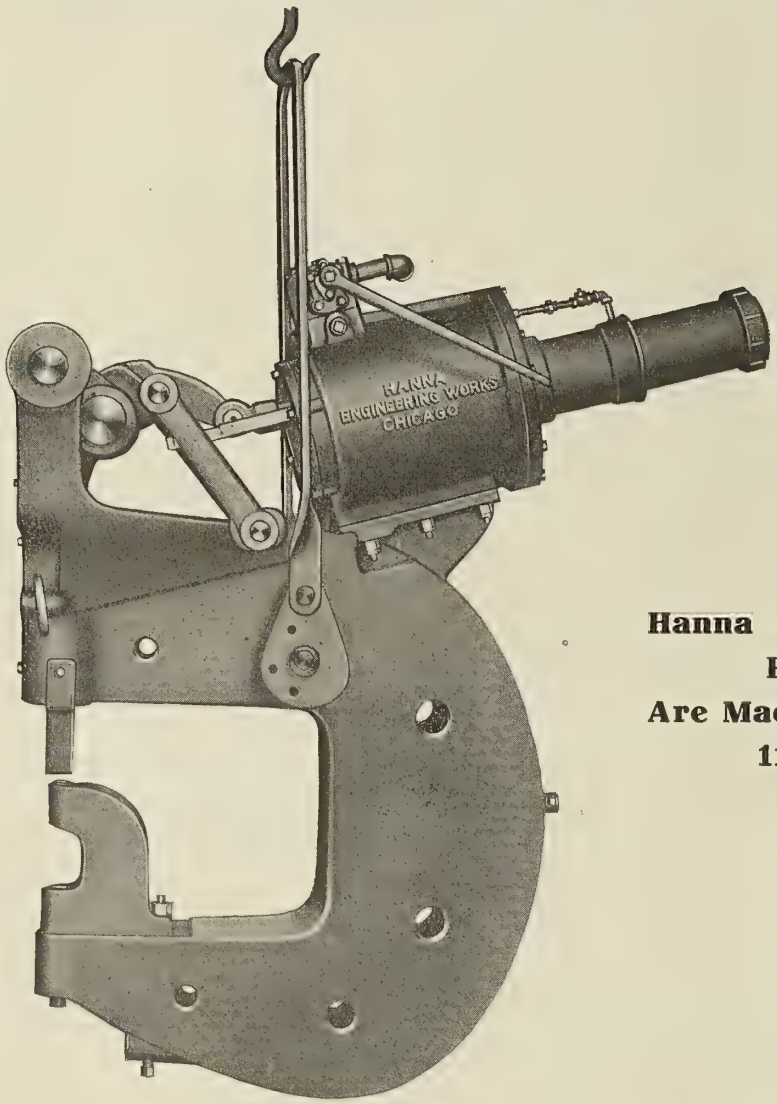

Figure 2425

Hanna Riveters Are Made in 115 Sizes

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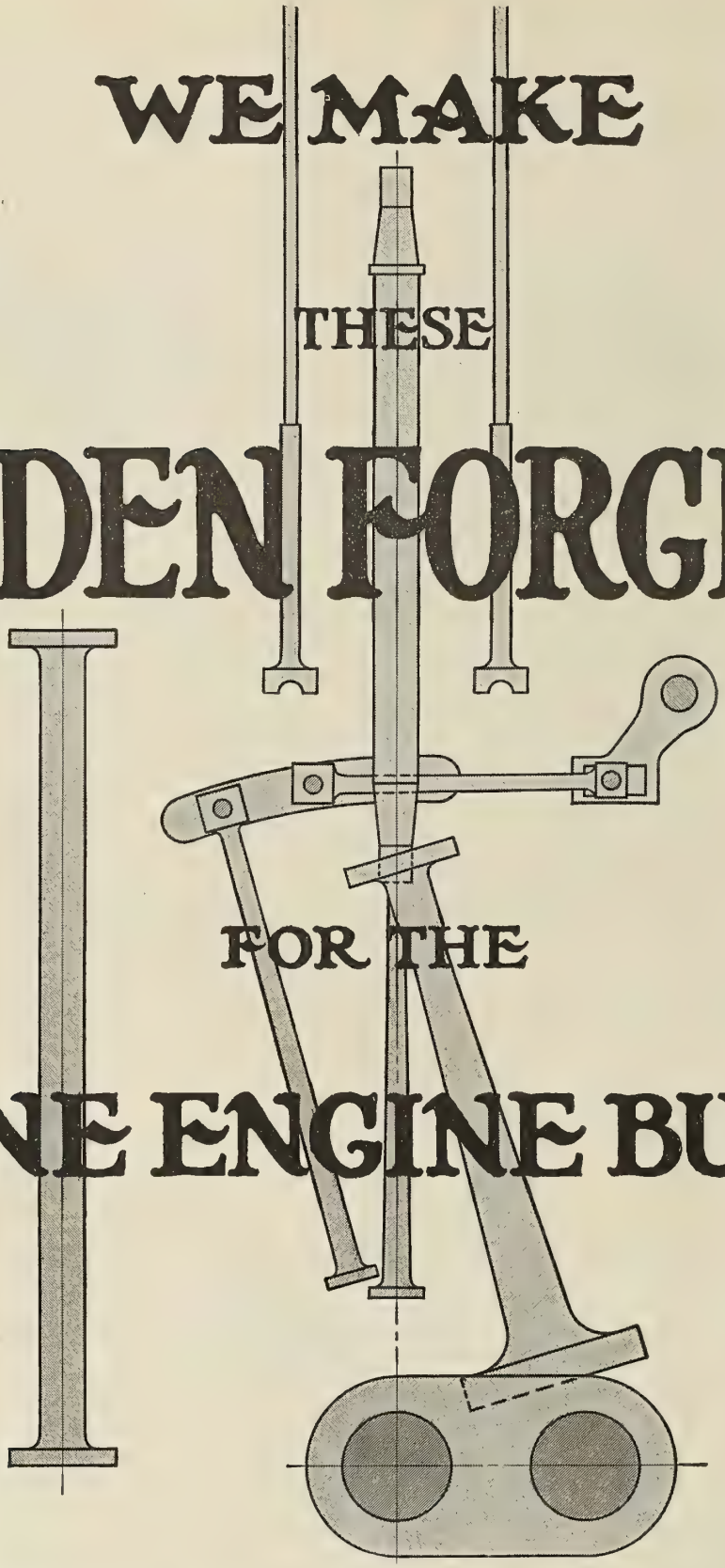

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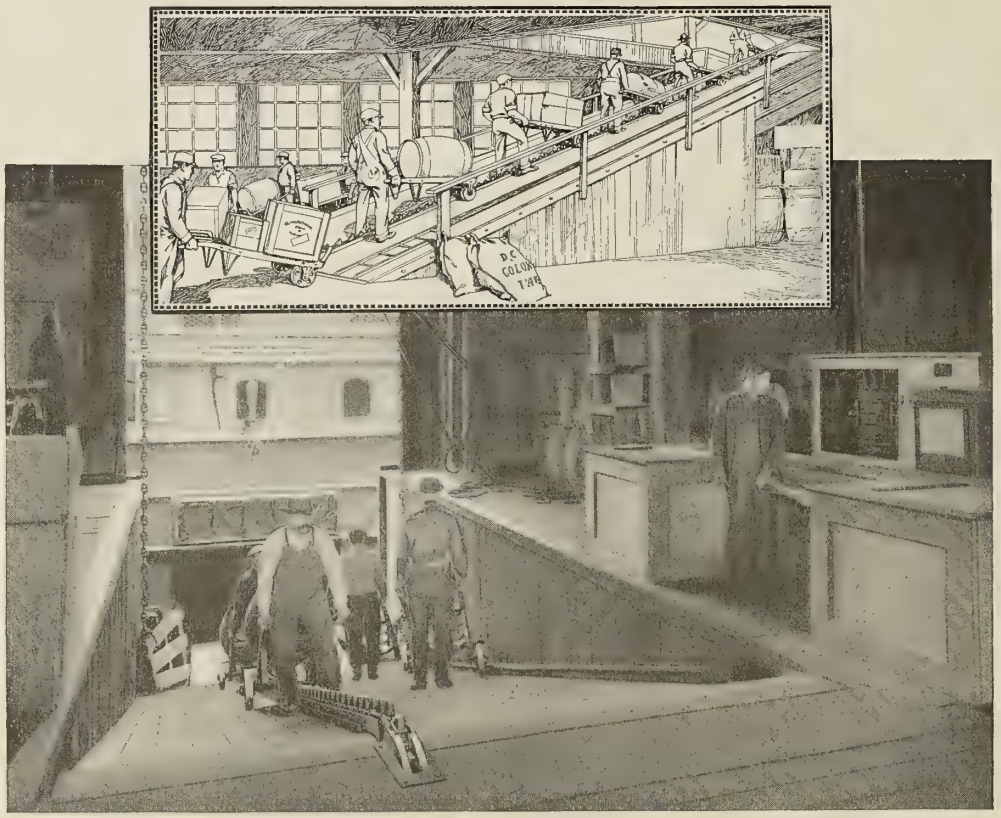

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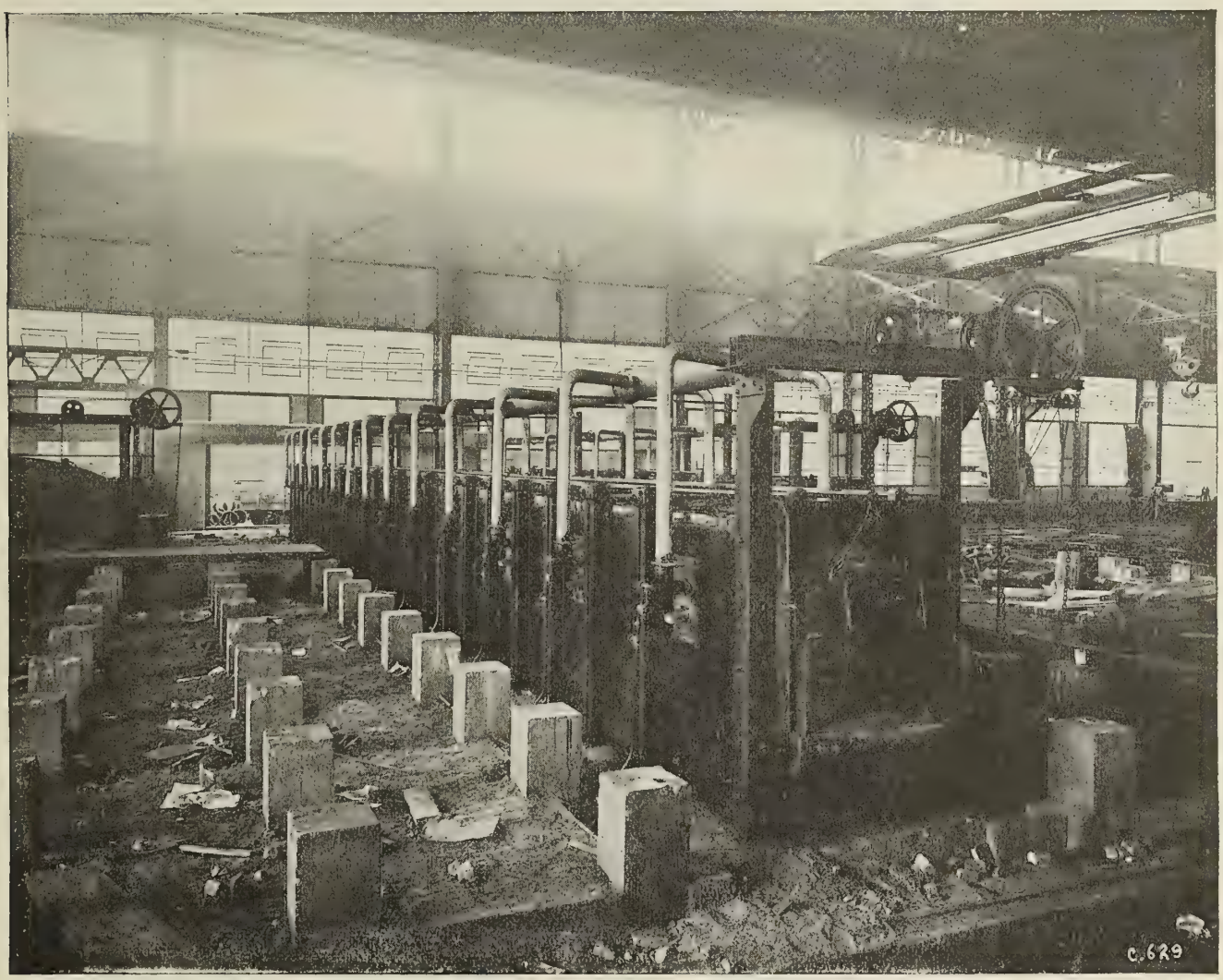

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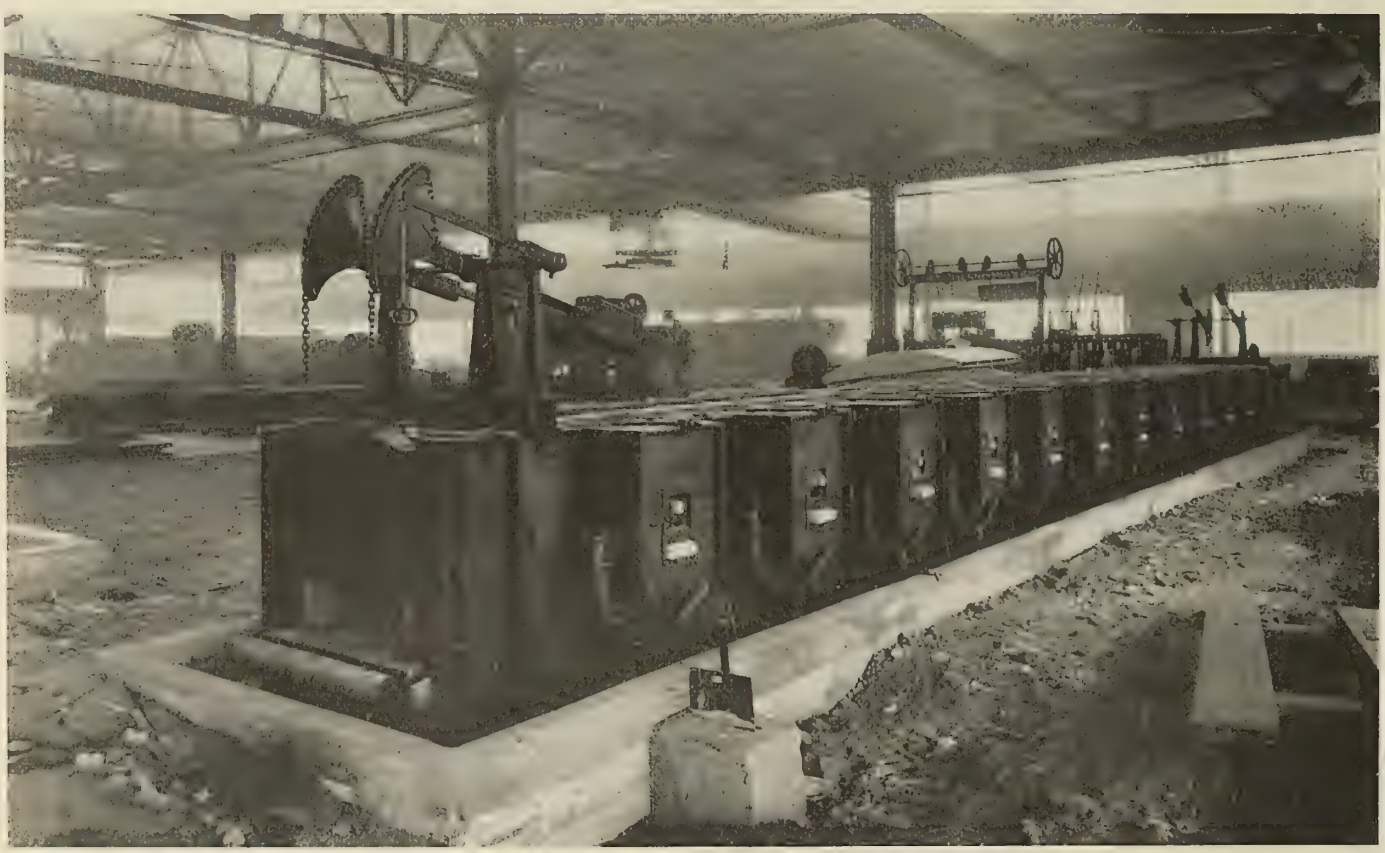

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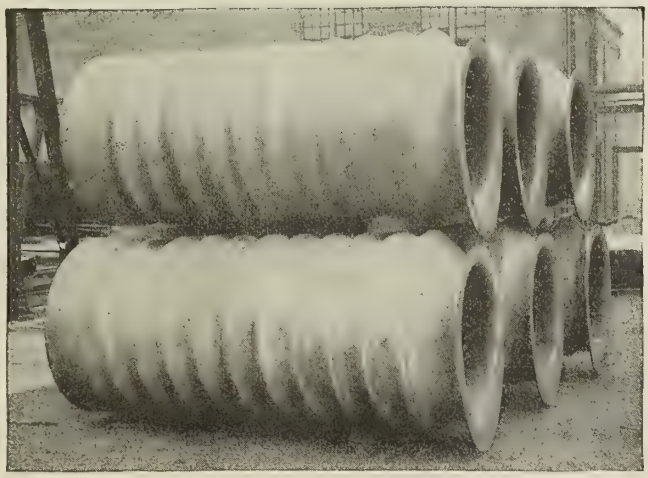

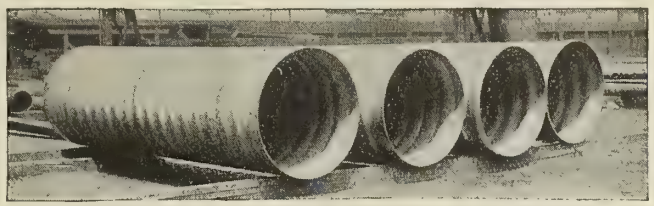

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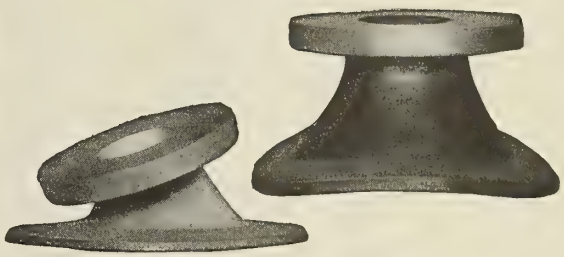

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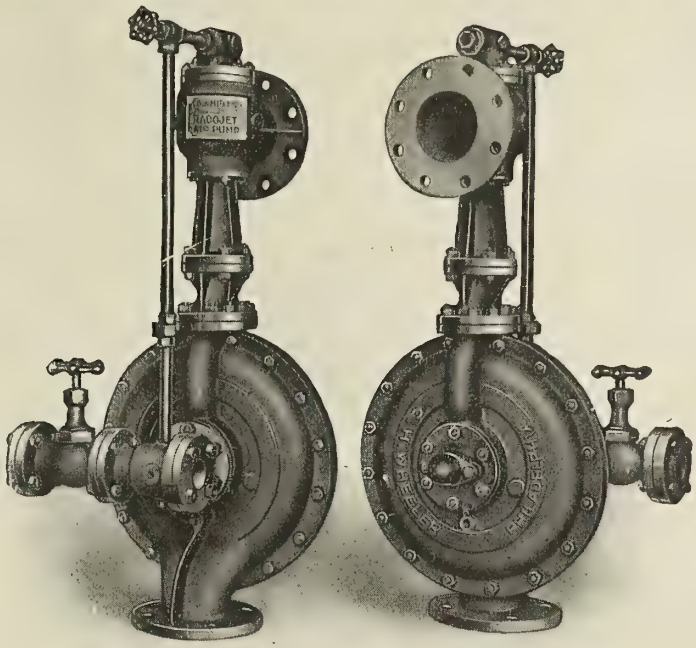

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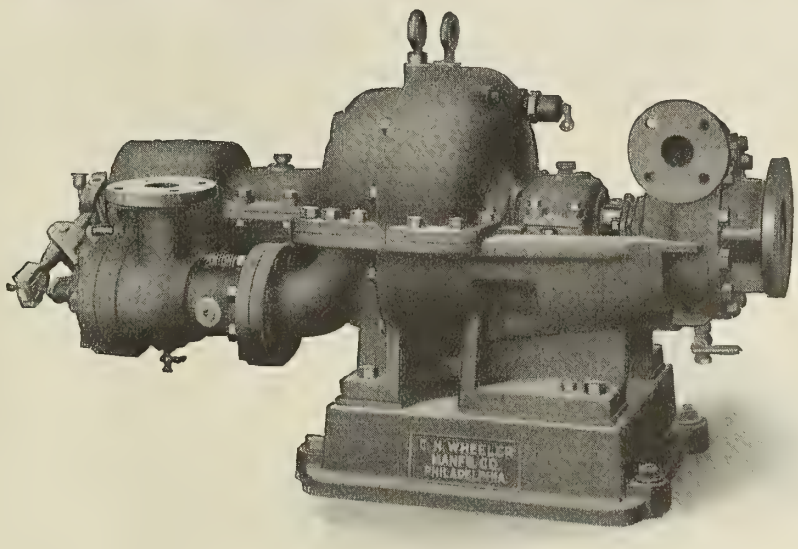

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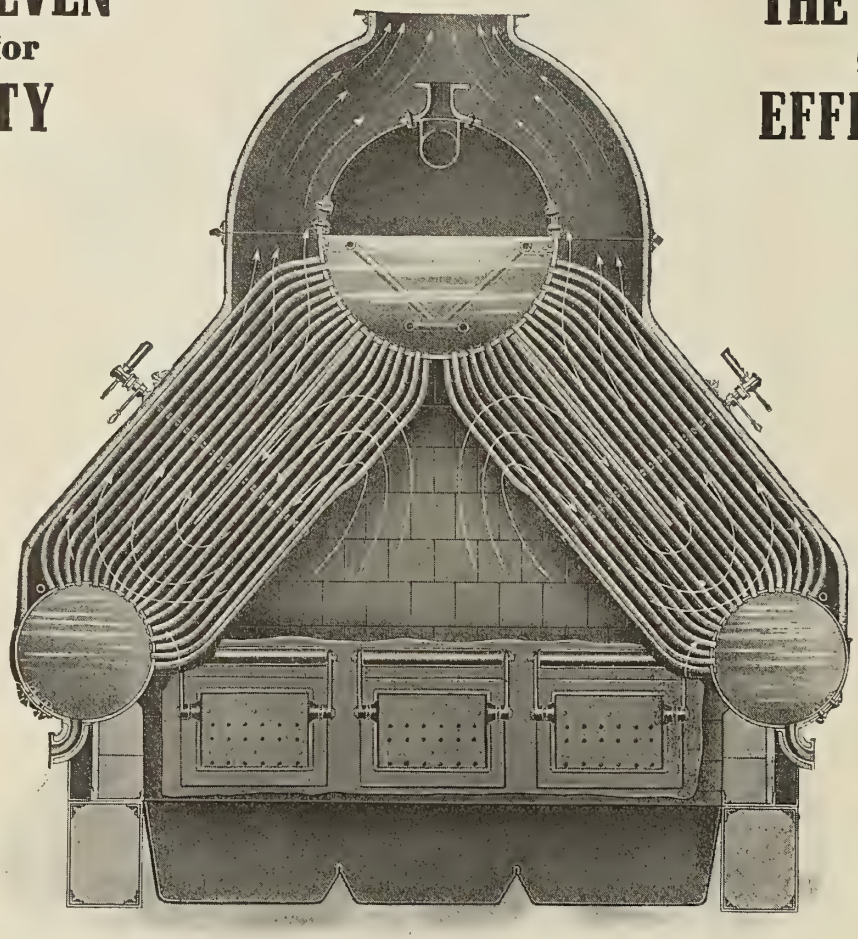

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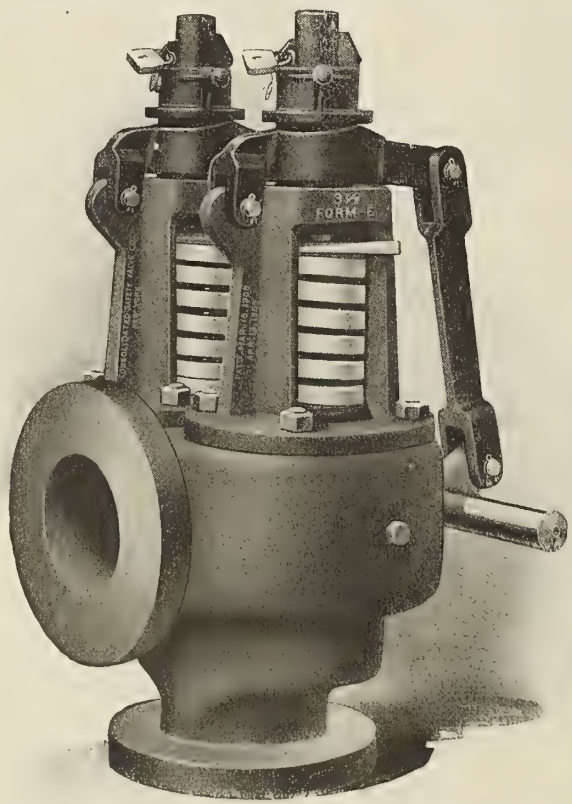

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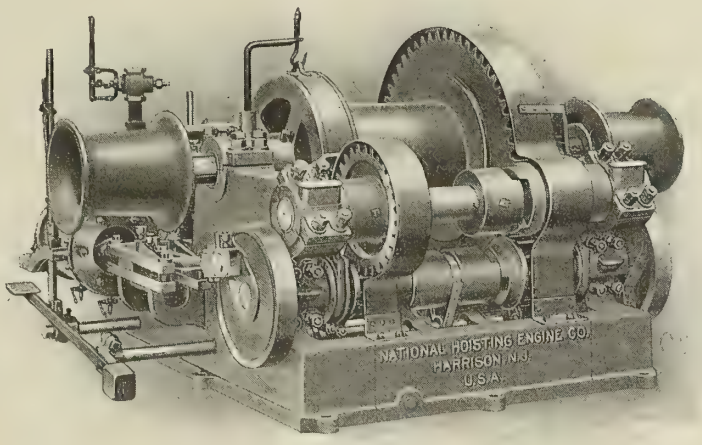

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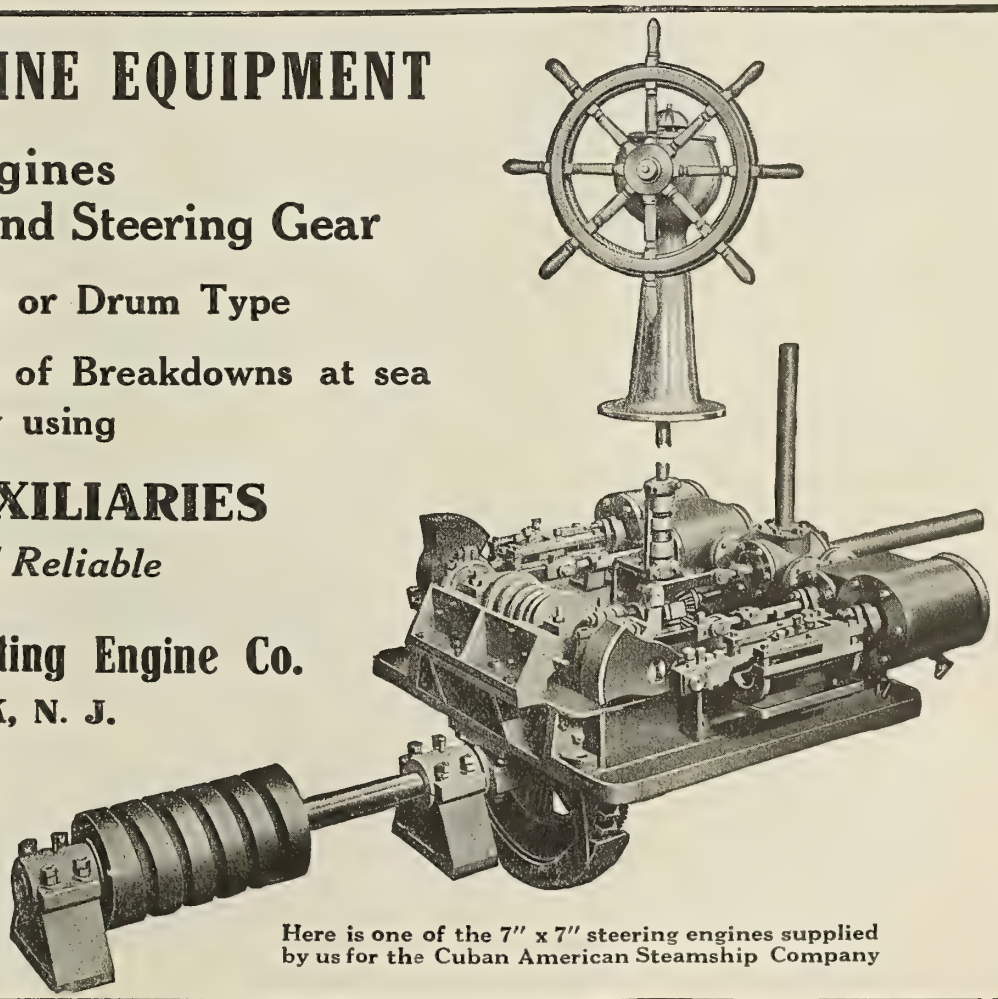

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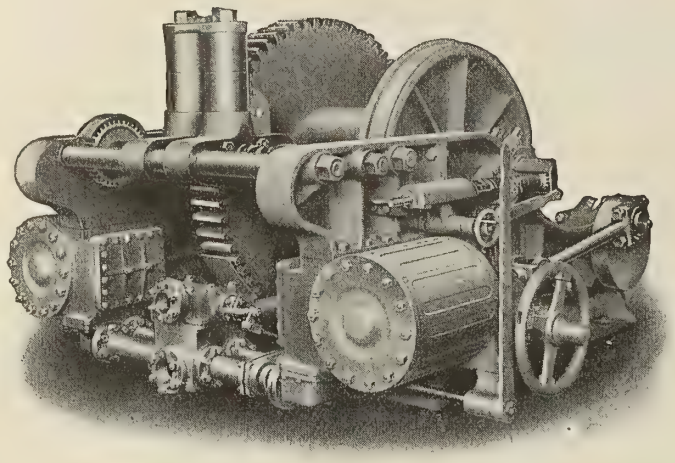

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The corkscrew motion caused by a quartering sea in a gale is handled in the same way.

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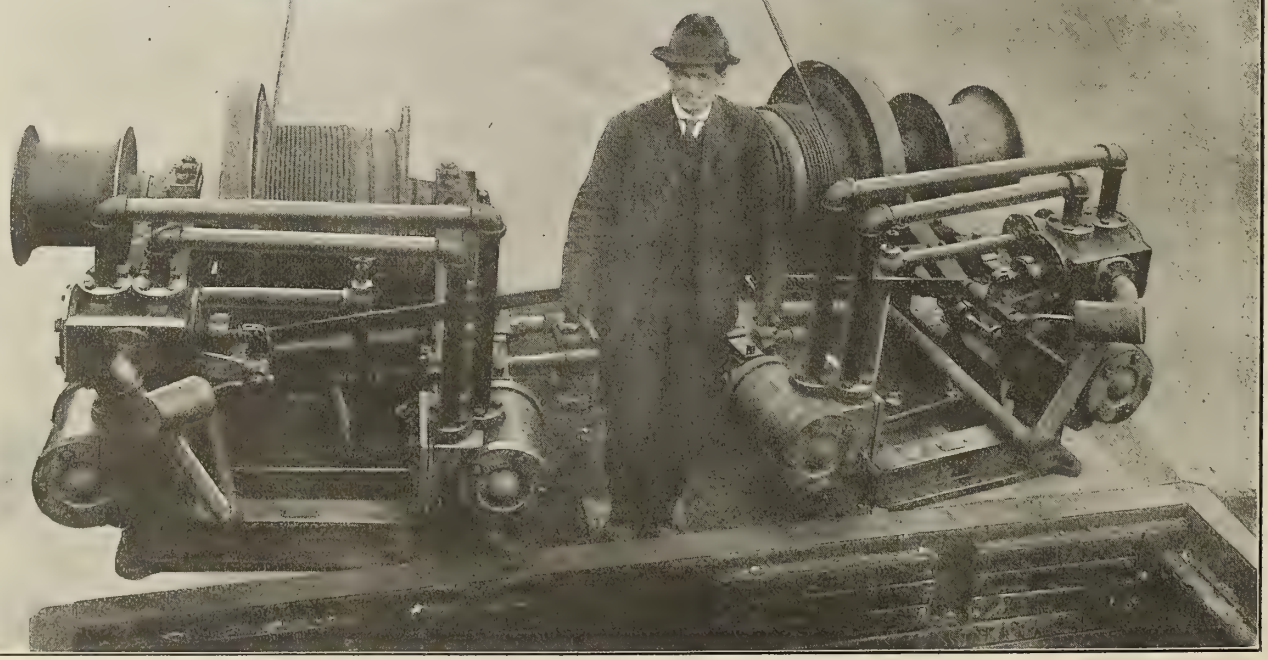

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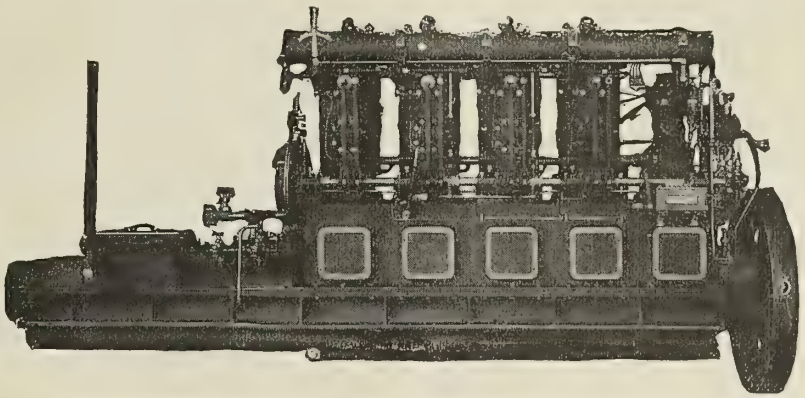

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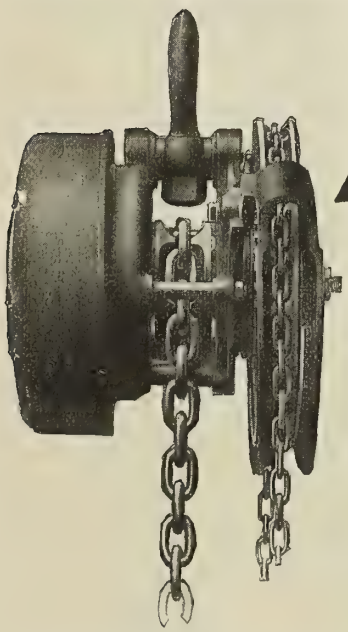

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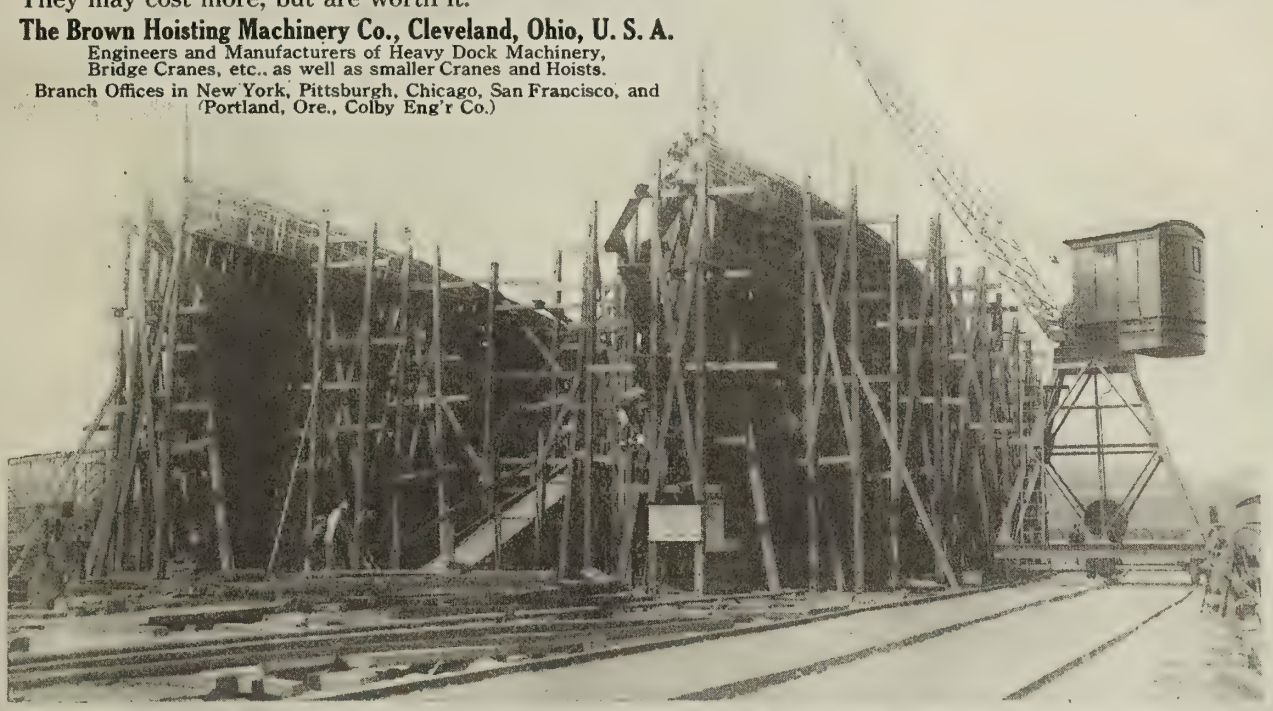

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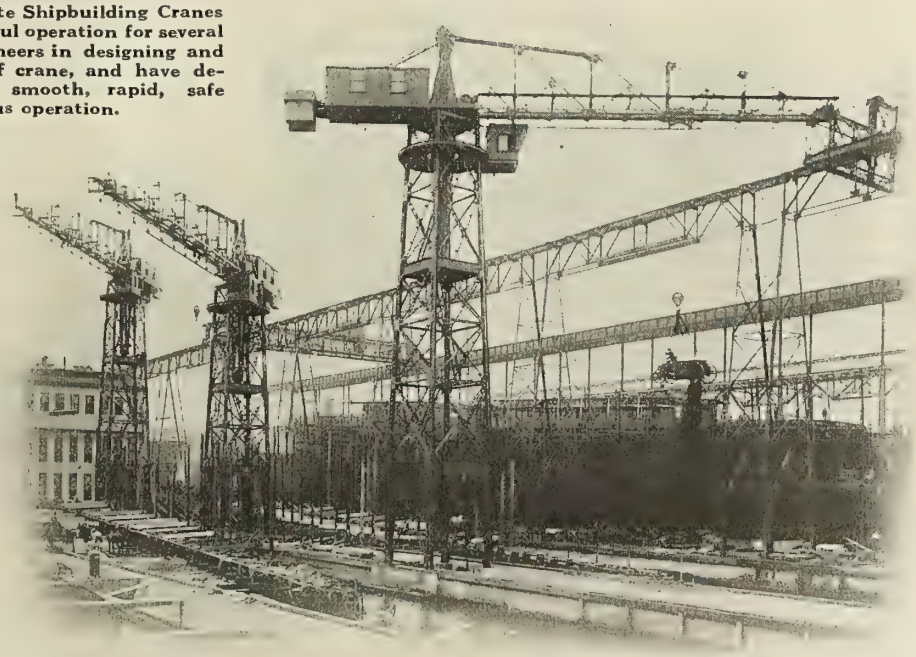

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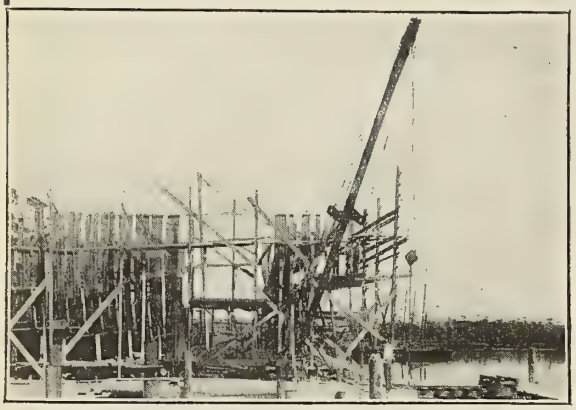

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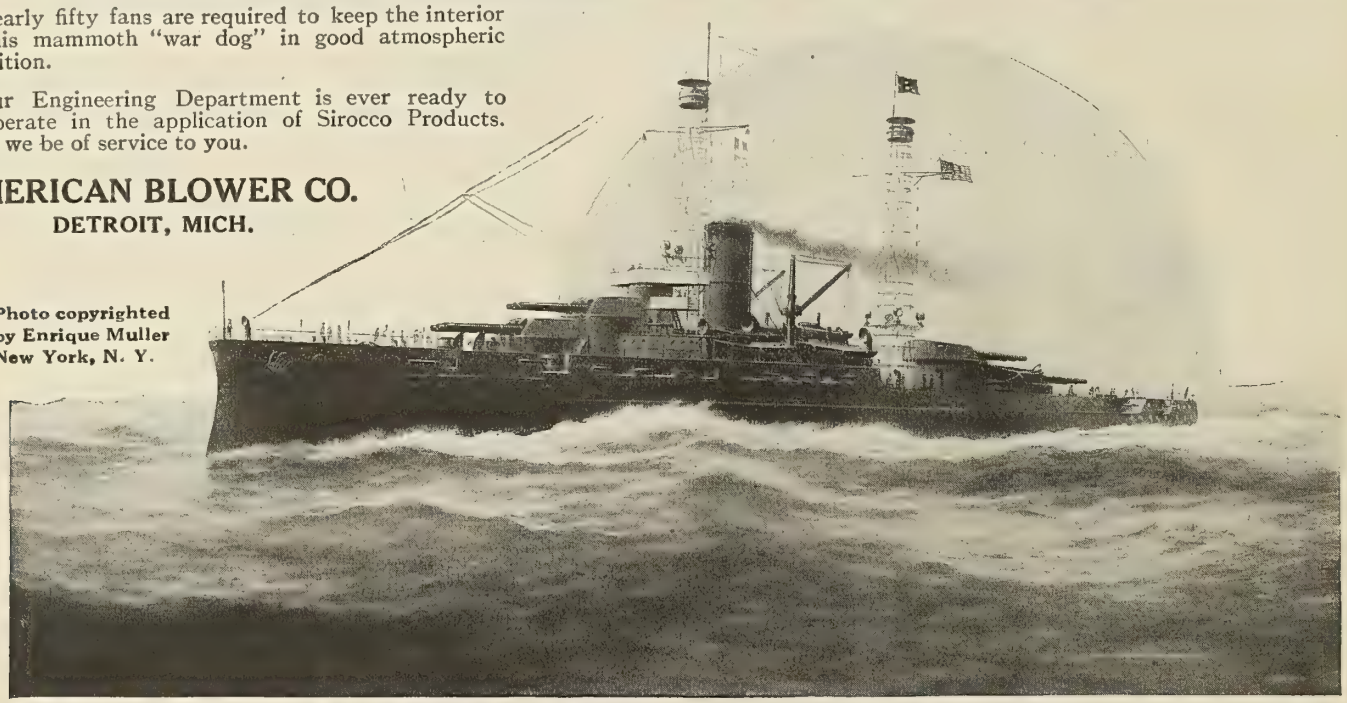

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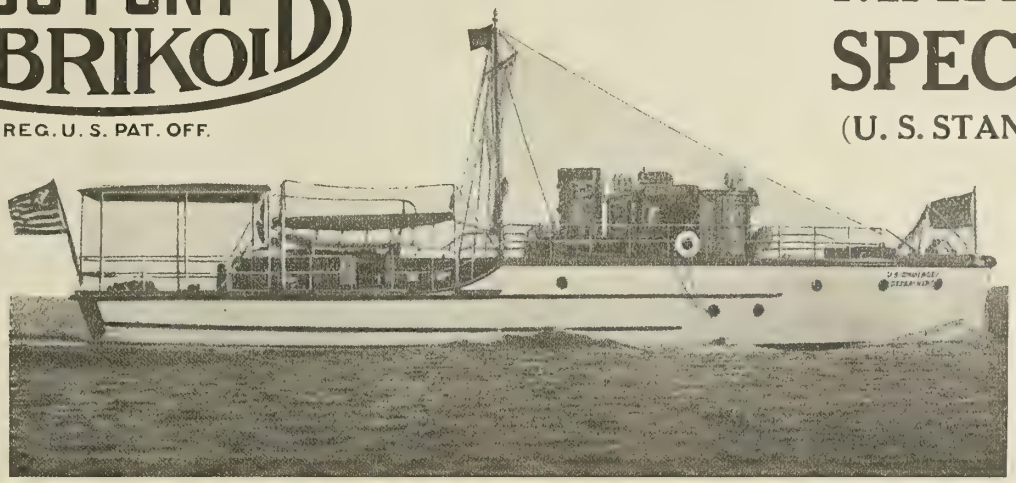

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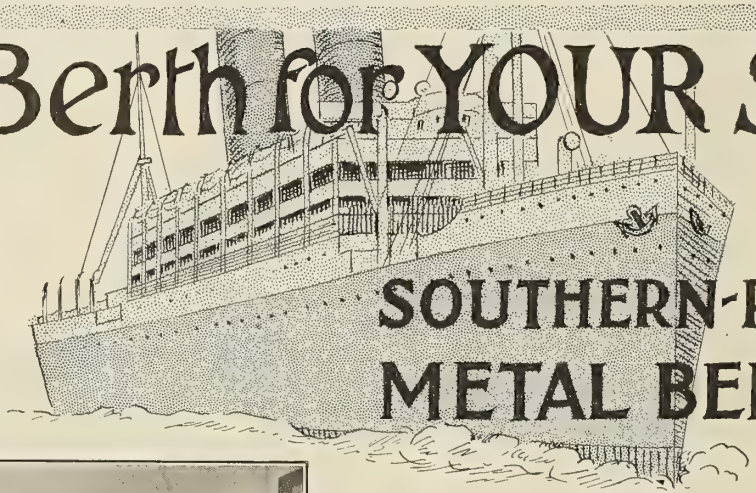

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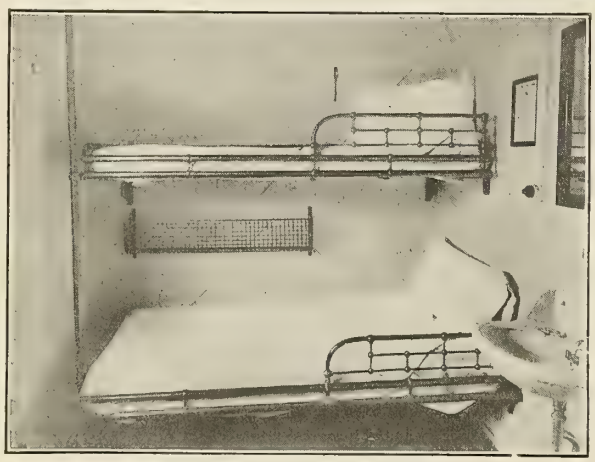

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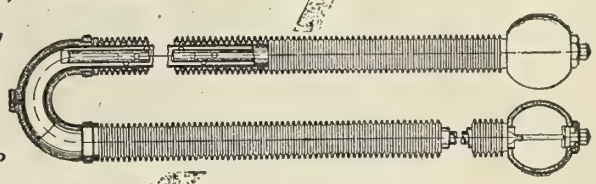

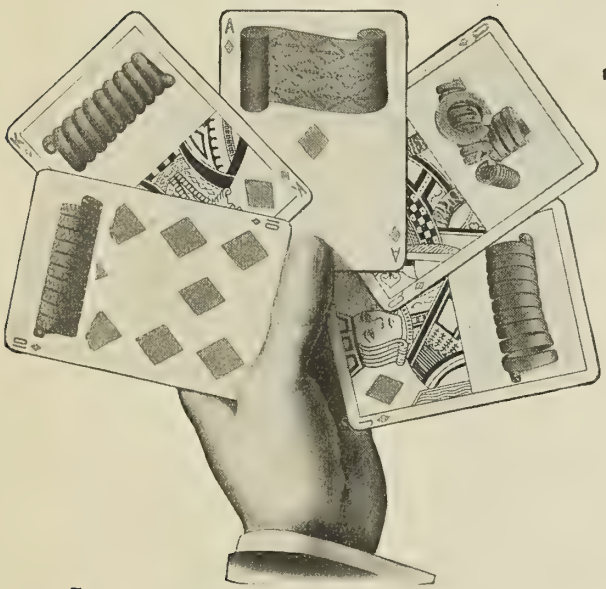

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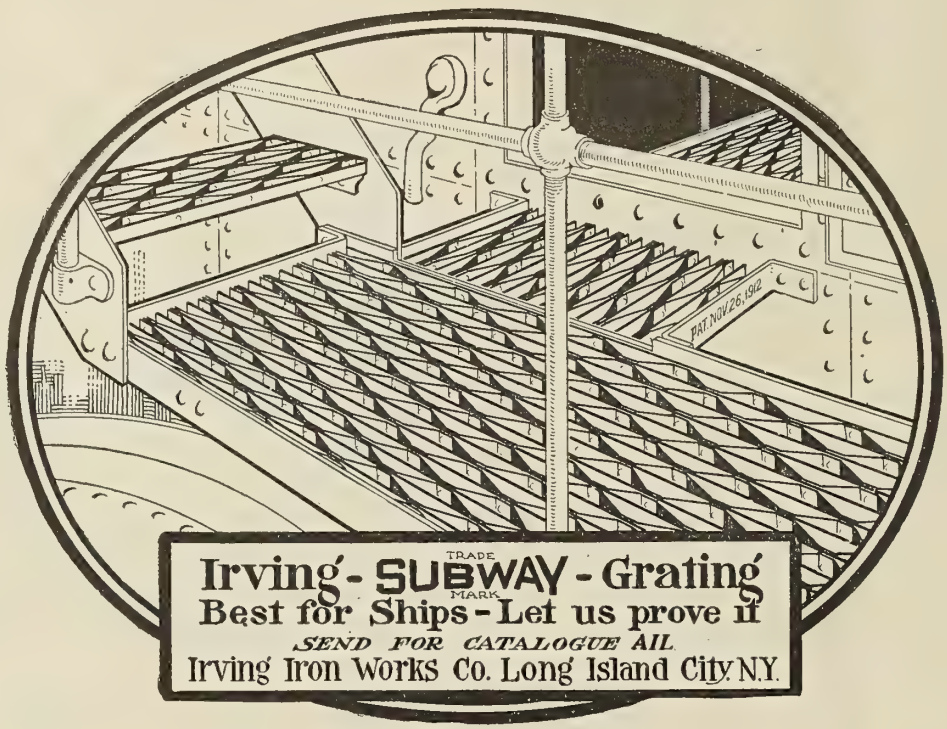

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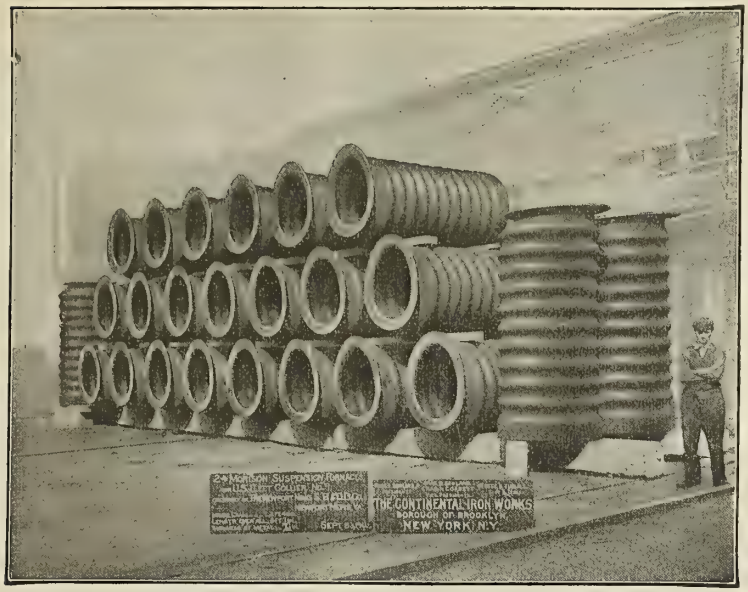

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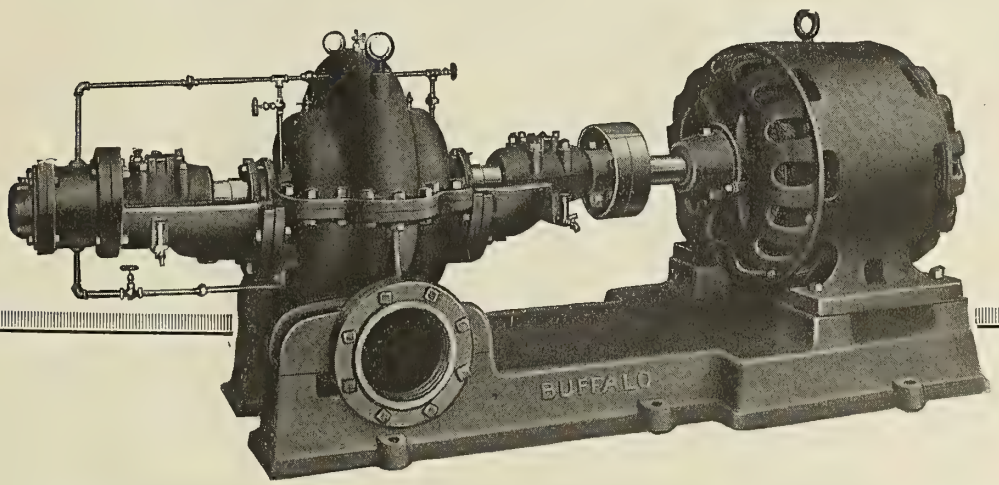

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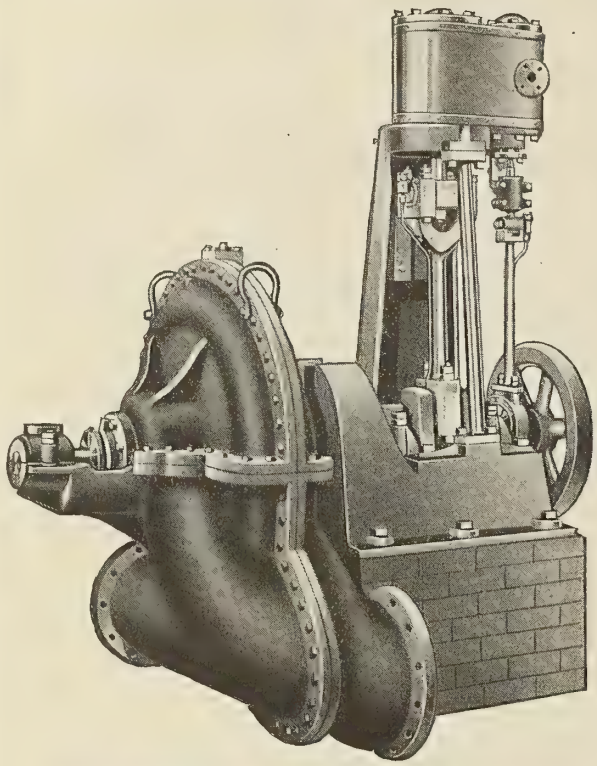

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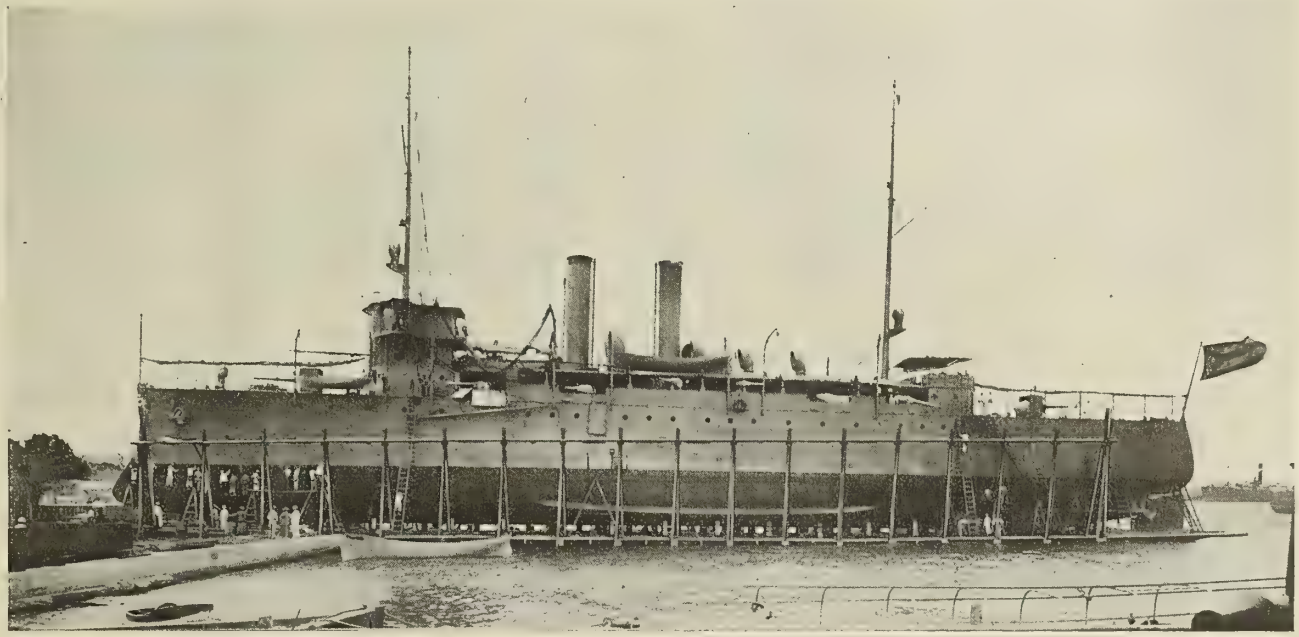

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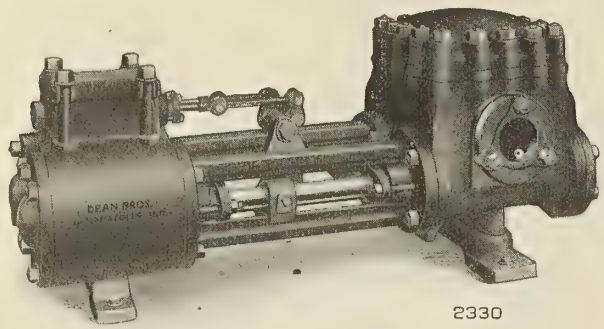

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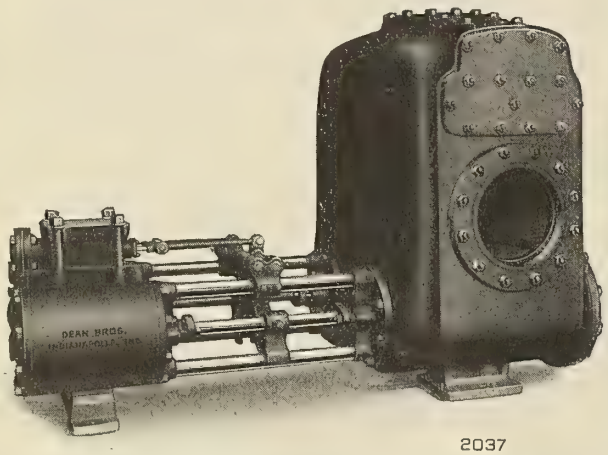

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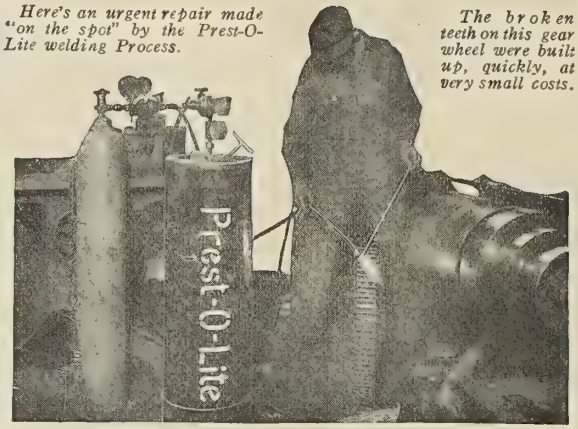

Saves Time and Money on Speedy Repair Jobs

For repairing operating machinery quickly—when a breakdown threatens a shutdown—oxy-acetylene welding is saving time, money and eliminating the necessity of purchasing many expensive replacement parts.

The Prest-O-Lite outfit is portable—enables you to effect permanent metal repairs *anywhere in the plant* at relatively low cost.

In thousands of shipyards, machine shops, factories, foundries, etc., the Prest-O-Lite Process is making big savings in repair work alone—reclaiming thousands of dollar's worth of valuable metal parts and castings from scrap heaps.

Wherever you have a problem of joining two pieces of metal—in the construction of boilers, tanks, piping systems, etc.;—or in the repair of operating machinery, remember the oxy-acetylene process deserves your careful consideration.

Prest-O-Lite PROCESS

Employs both gases (acetylene and oxygen) in portable cylinders. Acetylene supply is backed by Prest-O-Lite Service, which insures prompt exchange of full cylinders for empty ones. Provides dry, purified gas, insuring better welds, quicker work, and lower cost; also avoids large initial outlay and depreciation.

Necessary equipment is not expensive. We furnish high-grade welding apparatus for $75 (Canada $100); acetylene service at additional cost. Adaptable for oxy-acetylene cutting by the addition of special cutting blow pipe. Thorough instructions are furnished free to every user of Prest-O-Lite Dissolved Acetylene—any average workman who understands metals can learn the process quickly and easily

We invite you to put your metal-joining problems up to our engineers. Let us help you find the place in your plant where welding will do quicker, better work than any other process.

The Prest-O-Lite Co., Inc.

U.S. Main Office and Factory, 871 Speedway, Indianapolis
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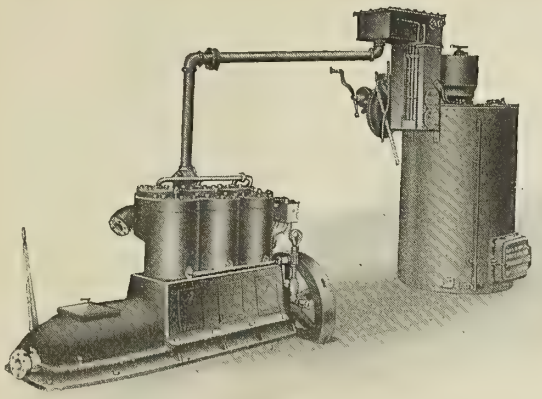
59 Branches and Charging Plants

World's Largest Makers of Dissolved Acetylene



The Galusha Gas Producer **provides** the most economical marine power known.

Saves $540 a Month in Fuel Cost

Chicago, Ill., Sept. 29, '17.

Mr. H. Jacobsen,
25 No. Dearborn St., Chicago, Ill.

I have a 50-H. P. Galusha Gas Producer in connection with a 60-H. P. Engine installed in my Passenger Boat the "CHICAGO" plying between Lincoln Park, the Municipal Pier and Grant Park.

Here is a brief report or data of the operation during this summer:—

I have run my boat every day, (a few rainy days excepted) from about 9 A. M. to 11 P. M. without losing one minute, and I run the engine "dead slow" at the docks without any danger of stalling. This shows absolute reliability.

The consumption of Pea Coal has amounted to not over 1½ tons of coal a week or a cost per day of less than $2.00 while gasoline would have cost me $20.00 per day, a saving in cost of fuel of some $540.00 per month. This is real Economy.

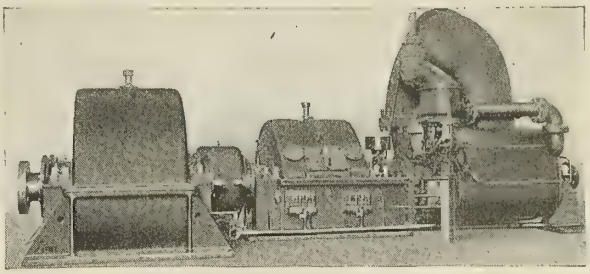
I have run my boat all day in storms and heavy seas, when all the "double deckers" had to tie up at their docks, and this weather did not interfere with the operation of the gas producer at all.

To prove my satisfaction, I will add, that I shall most certainly install this kind and make of power in my next boat.

Very truly,
FRED WEIMER

NELSON BLOWER & FURNACE COMPANY

17 Elkins Street South Boston, Mass.



Every De Laval Unit Is Guaranteed And Tested

The photograph shows a De Laval Geared Marine Turbine unit, erected on our test floor, where it is given a thorough try-out before shipment.

This protects you against errors in design or construction, and at the same time supplies our Engineering Department with the means of checking and improving the data used in the designing room.

This policy has been followed consistently by us in the manufacture and sale of steam turbines, speed-reducing gears, and centrifugal pumps and blowers for the past twenty years.

Another practice of great interest to buyers of machinery is our thorough-going use of limit gages and the resulting interchangeability of parts. Every part of a De Laval machine is stamped with a distinguishing symbol. By wiring or writing our home office an exact duplicate can be obtained which can be installed in the machine without requiring to be fitted or otherwise modified. This protects you against loss of time or mal-adjustment of parts. By replacing parts especially subject to wear such as bearings, or turbine blades, etc., the machinery, can at small expense, be brought back to its original high efficiency.

State character, speed and size of boat and other particulars and full information with Catalog M 46 will be forwarded.

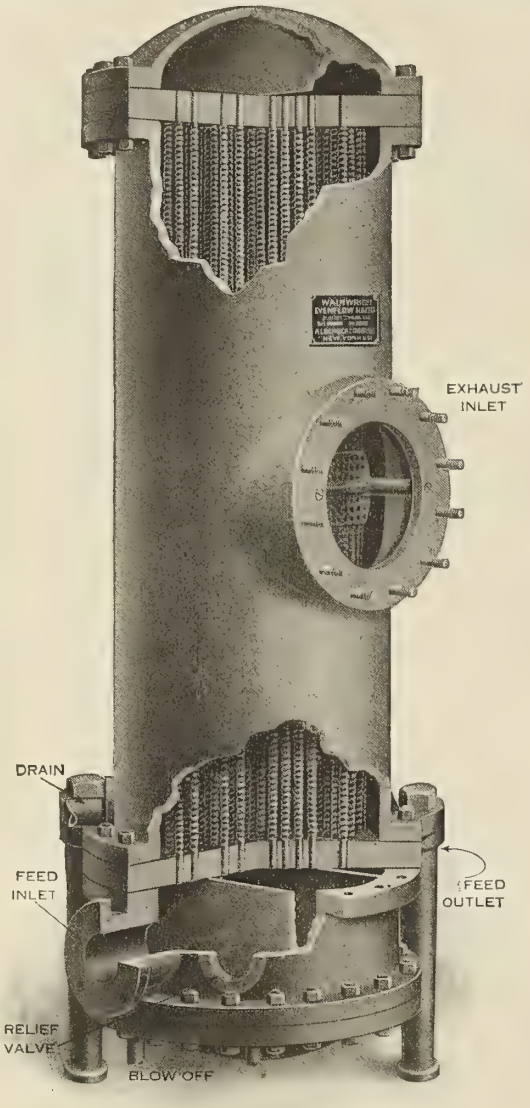
DE LAVAL

STEAM TURBINE CO.

Trenton, New Jersey 276

"Alberger—Always Ahead"

Wainwright Closed Heaters



The Interior Construction of the Wainwright Vertical Boiler Feed Water Heater

CORRUGATED TUBES give maximum heat transmission rate.
SEPARATE WATER CHANNEL gives convenient access for cleaning out, etc.
PLAIN COVERS, without pipe openings. When removing cover for inspection not necessary to break a pipe connection.
STRAIGHT TUBES, easily inspected.
EASY TUBE REPLACEMENT, as all tubes are straight, both ends all tubes easily accessible, any one tube may be removed without disturbing any of the others.
CAST IRON SHELL, not subject to rapid corrosion.

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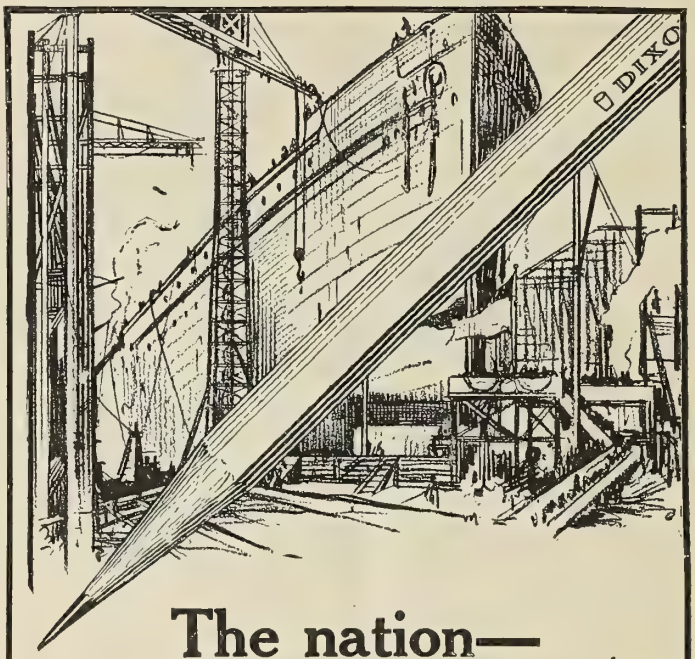

The nation—the vessel—the pencil

The very existence of the nation depends upon its vessels—warships and merchant marines.

The efficiency of those vessels depends first of all upon the drafted plan—the pencil.

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"the master drawing pencil"

is the pencil of big things. It means quick work because the leads hold their points longer and stand unusual pressure without breaking. It means reliable work because the leads are smooth, gritless—true to grade in each of the 17 degrees.

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Naval Vessels **Merchant Steamers**
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These boilers hold the record for economy, capacity and endurance in the Navies of the World.

They have shown the same characteristics in the Merchant Marine. Babcock & Wilcox Boilers and Superheaters in one vessel are *saving more than 15 per cent.* over Scotch boilers in sister vessels.

Is a reduction in your coal bill of any interest to you?

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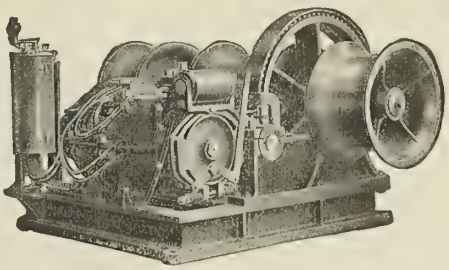
We are constantly receiving "repeat orders" from owners of merchant vessels who have had many years' satisfaction from the earlier installations.

Write us for details



Rapidity in Unloading Vessels Means An Increase in Earning Power of Thousands of Dollars Each Voyage

Mead-Morrison Electric Cargo Hoist with One Fixed Drum and Two Fixed Winch Heads

Designed specially for use on docks where it is the custom to use the winch heads rather than the drum for unloading cargo. The drum and both winch heads are of the same diameter and all keyed to the same shaft.

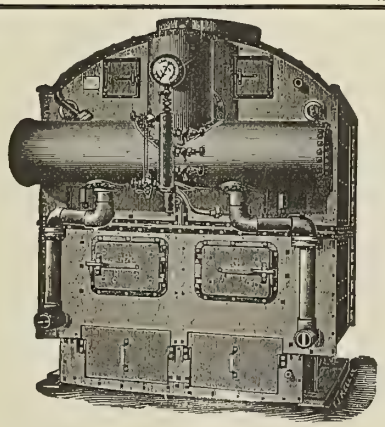
Hoist is usually used with a motor of about 20 horsepower which gives a capacity of 2,000 pounds pull on single line at a speed of 250 feet per minute.

Motor is fitted with a solenoid brake for sustaining load when current is shut off.

MEAD-MORRISON MFG. CO.

Prescott and Orleans St. **EAST BOSTON, MASS.**

Sales Representatives in the Princ pal Cities
Send for Pamphlet on Cargo Hoists and Ship Winches



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Boilers

for all marine purposes

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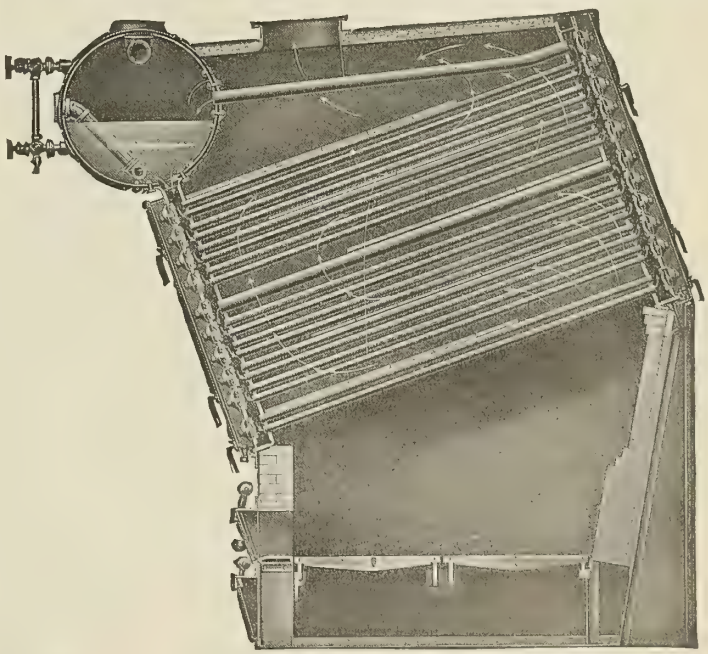
ADOPTED BY U. S. GOVERNMENT



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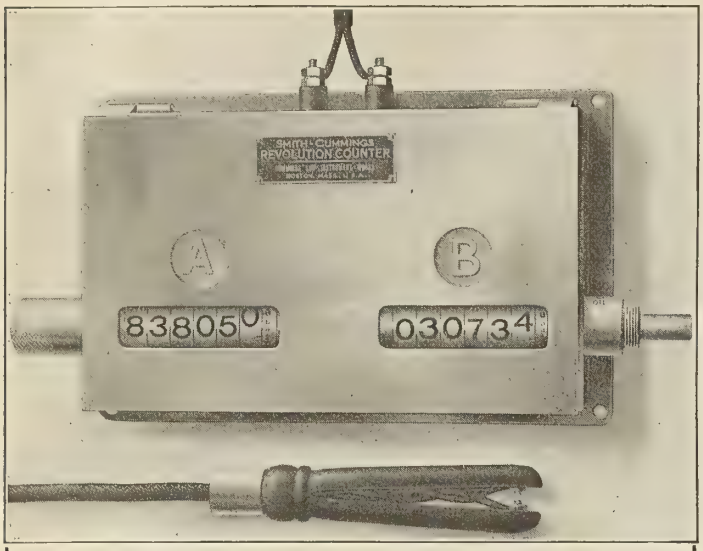

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For determining accurately revolutions for a given time or over a given course.

Used extensively in testing aeroplane motors and on trial trips of ships.

Controlled from bridge or at counter.

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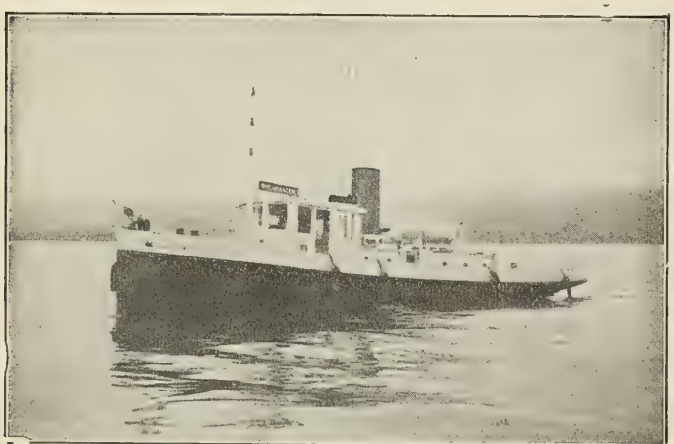

Tug "Breakwater", 75 ft., 300 H.P. Engine. Breakwater Co., owner

Three things give you low cost

LOW PRICE
INEXPENSIVE OPERATION
LONG LIFE

All are interdependent

The engine price can be so high that the interest on investment offsets the low operating expense.

The fuel and oil used can be so great that the operating expense quickly offsets a low engine price.

The wear on the engine can be so rapid that the short life quickly offsets a low engine price and a low fuel consumption.

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The large and rapidly increasing number of STANDARD-engined work-boats indicates that it may be the most practical and economical engine for your boat.

Let us figure your proposition with you. Send for catalogue.

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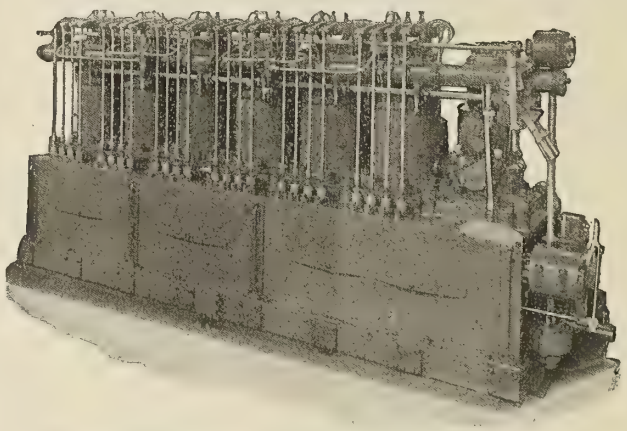

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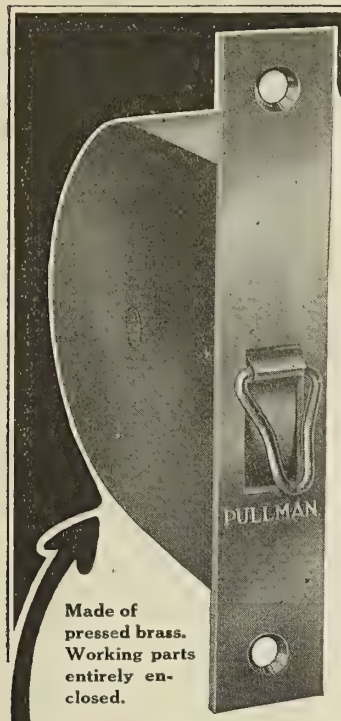

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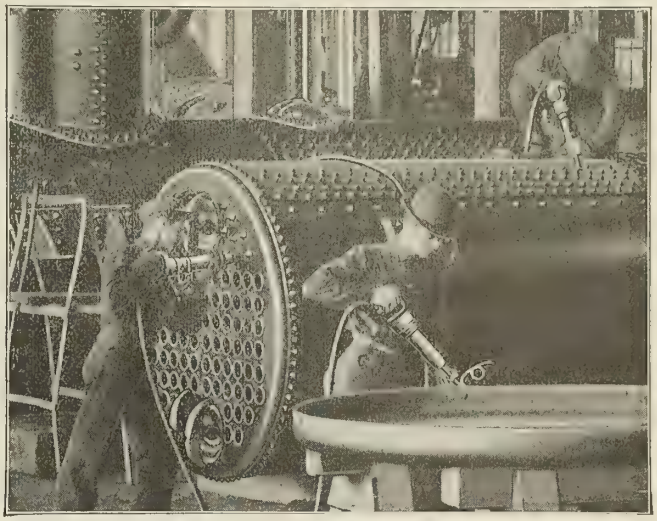

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Boyer Pneumatic Riveting, Chipping and Calking Hammers have been favorites for this class of work for over twenty-five years. In general use in Foundries, Boiler Shops, Car Shops, Steel and Iron fabricating plants and Shipbuilding Plants.

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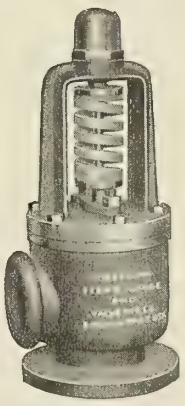

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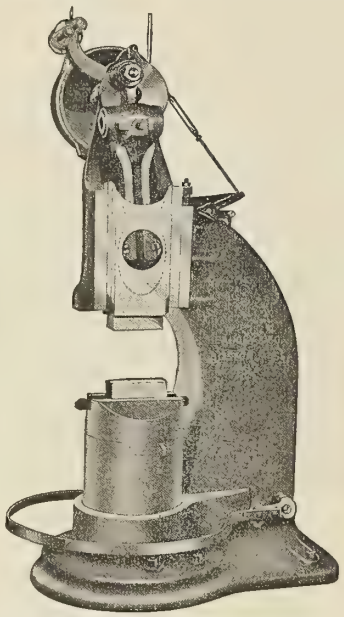

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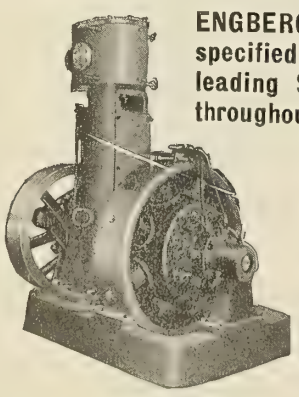

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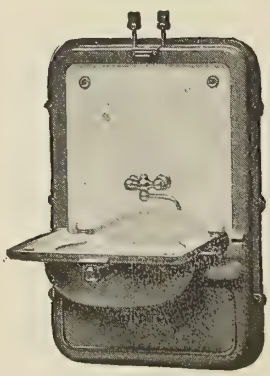

PLATE 1002-Y

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There is an integral splash rim on the inside of the bowl and one around the outer edge of the slab. Rubber-tipped spring bumpers prevent damage when opened and dropped suddenly. Basin can be lifted out for cleaning.

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We manufacture other types of lavatories in solid porcelain, vitreous china and enameled iron; pump and range closets, showers, bathtubs, urinals, water heaters, galley and pantry sinks; pumps for bath, lavatory and galley; sea cocks, toilet room accessories, etc.

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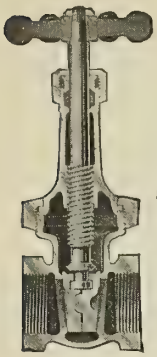

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AND this is especially true of the Williams Double Disc Gate Valve. For instance, there's the Union Ring feature. This makes a rigid union joint between bonnet and body and adds much to the strength of the whole construction. The joint cannot corrode or stick and is easy to disconnect should inspection or renewal discs ever become necessary. Remember also, that

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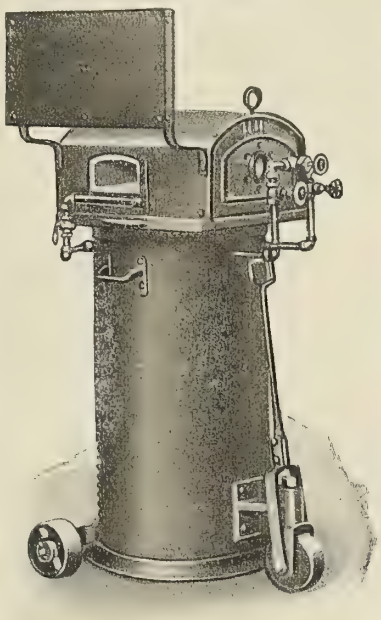
are designed for economy, production and efficiency, especially adapted for field use. Thousands in use all over the country. Designed for oil or gas fuel. The popular furnace is our No. 921.



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Heats 500 rivets per hour and takes rivets up to 1½ inches in diameter. Rivets always in plain sight. Working temperature obtained in 7 minutes.

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And Non-Striking Clocks—Practically Waterproof Cases, for use on YACHTS, STEAMSHIPS, MOTOR BOATS, HOUSEBOATS, AEROPLANES, SEAPLANES, Etc.

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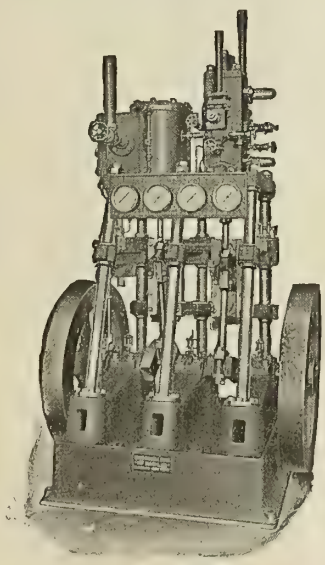

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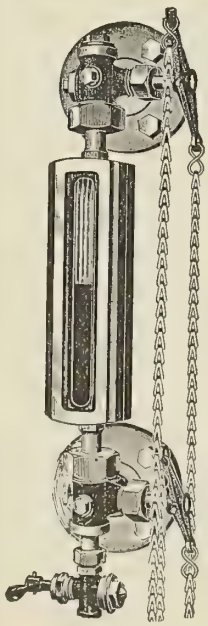

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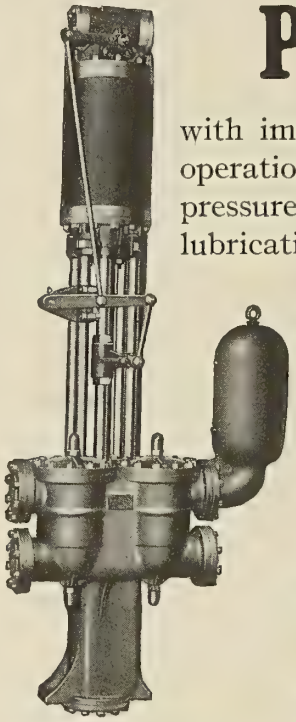

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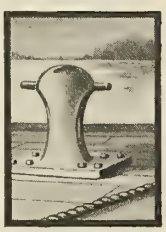

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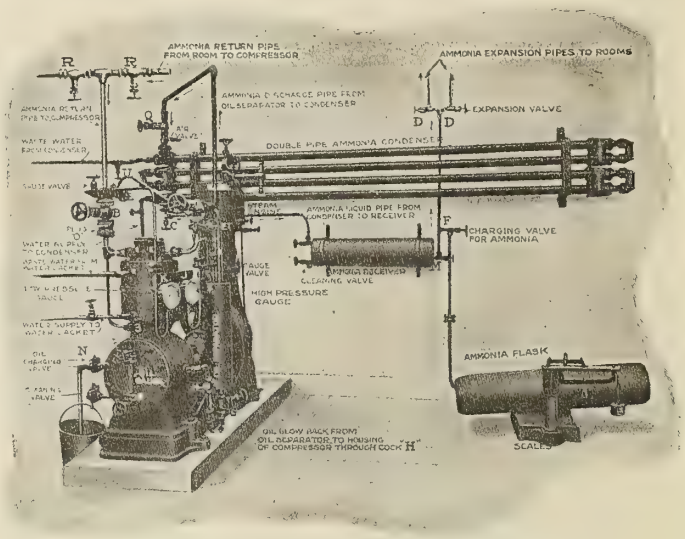

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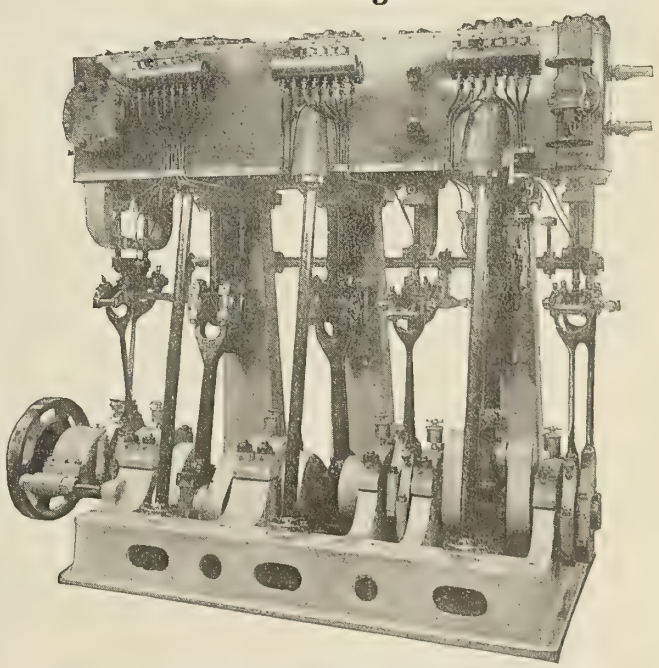

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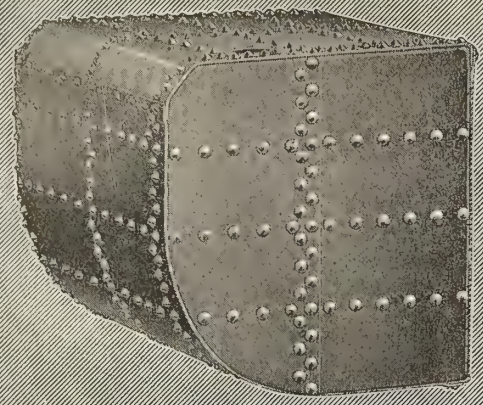

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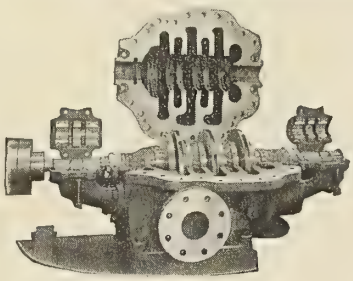

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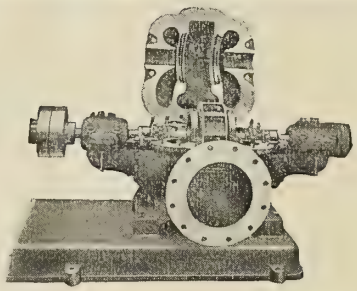

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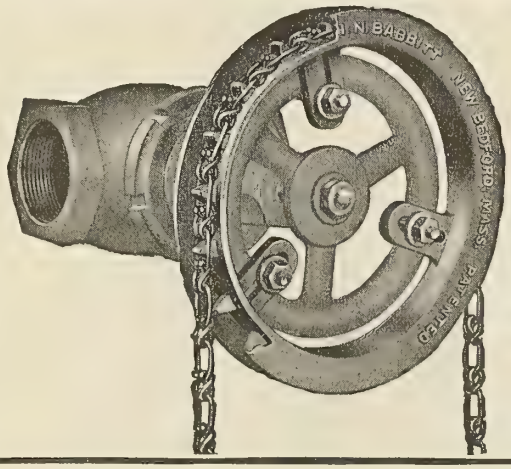

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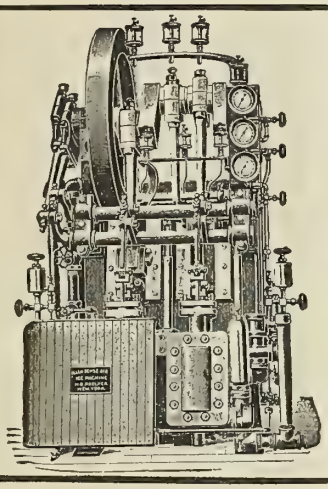

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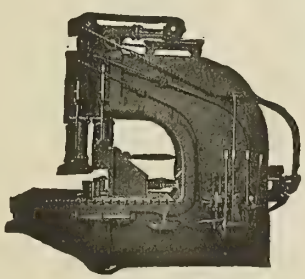

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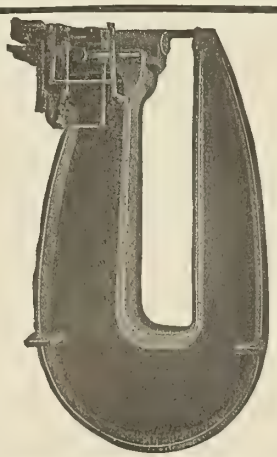

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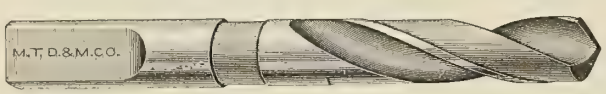

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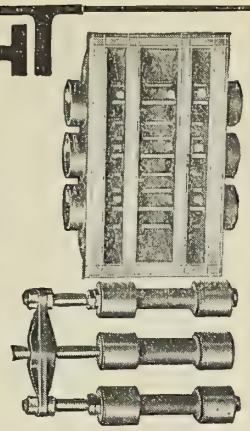

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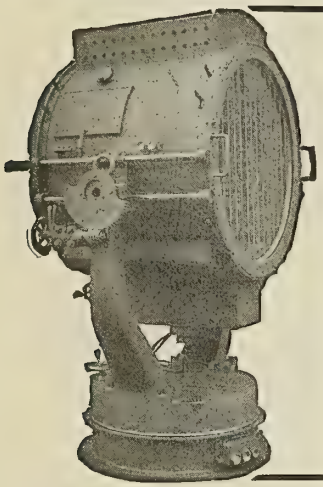

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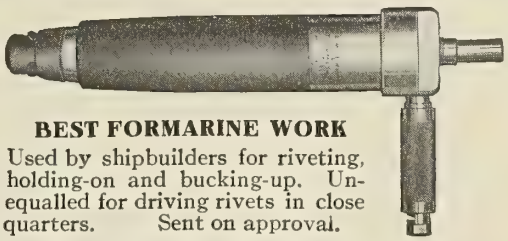

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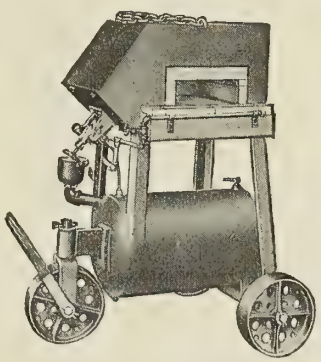

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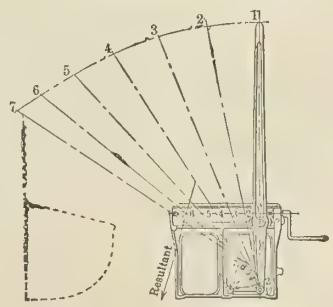

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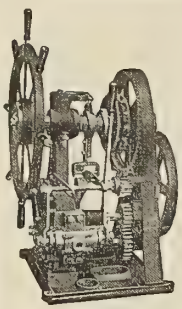

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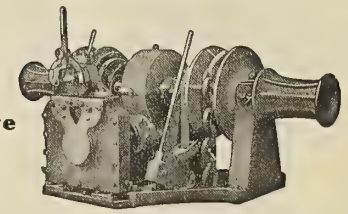

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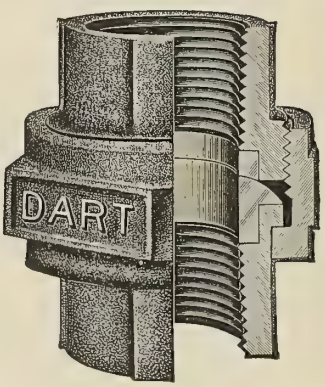

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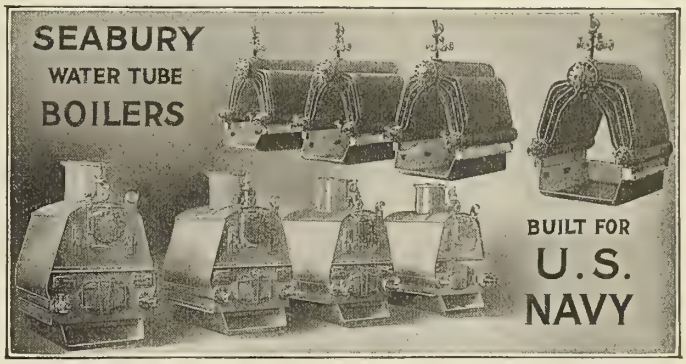

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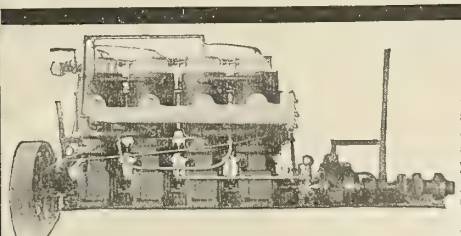

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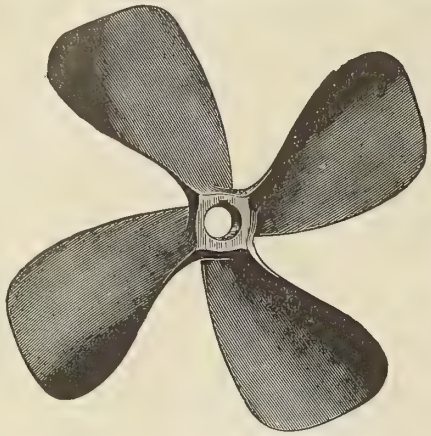

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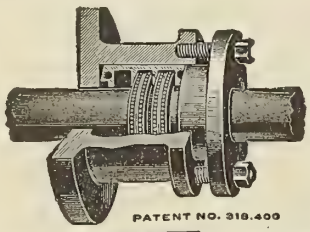
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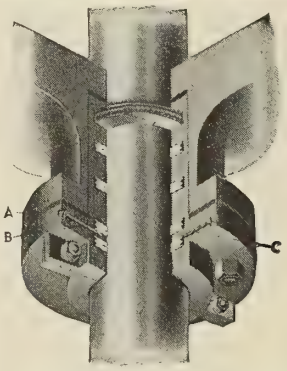

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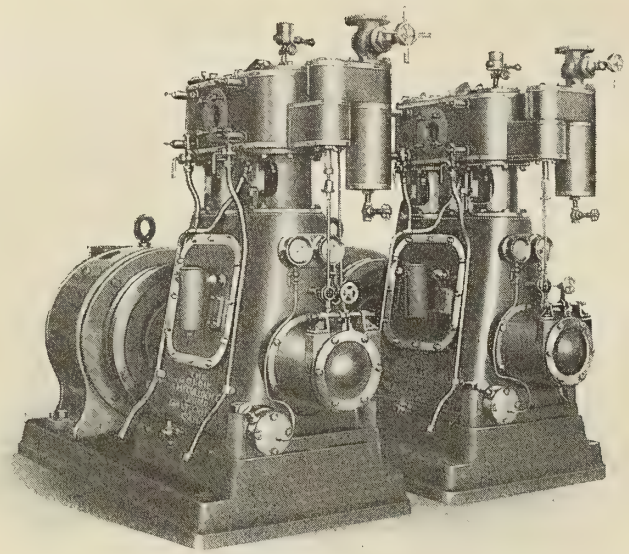

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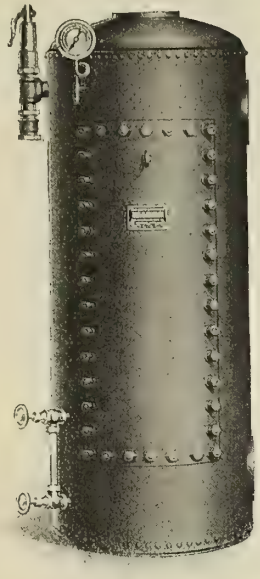

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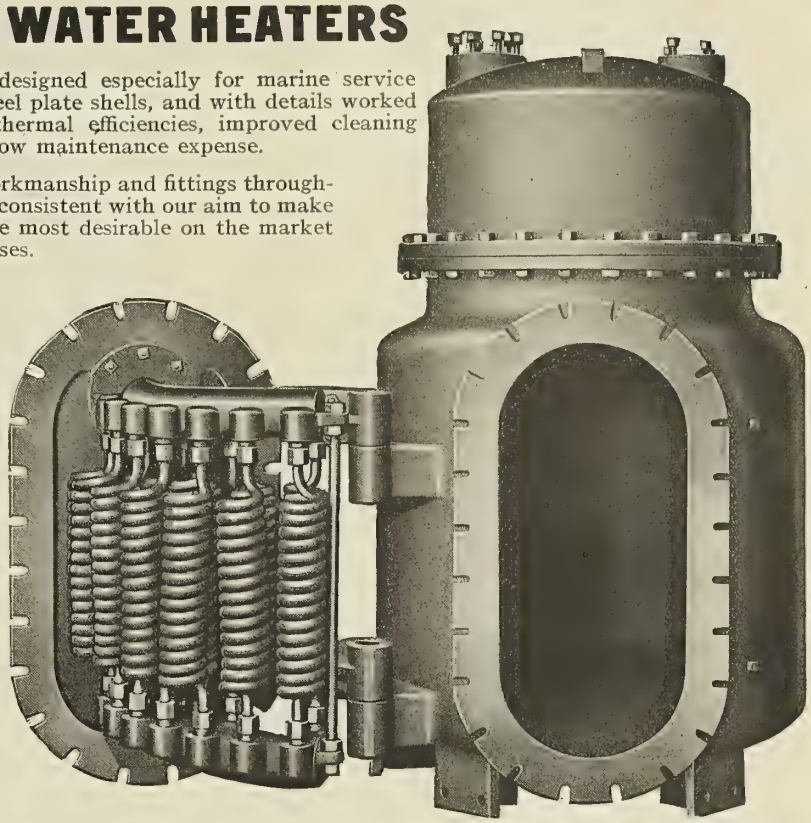

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Shepard Elec. Crane & Hoist Co.

Coolers, Air.
(See Air Coolers.)

Coolers for Oil.
Schutte & Körting Co.

Copper.
(See Brass and Copper.)

Copper Paint for Wooden Vessels.
International Compositions Co.

Cordage.
(Also see Rope and Wire Rope; also Twine.)
Columbian Rope Co.
Durable Wire Rope Co.
Griscom-Russell Co.
Plymouth Cordage Co.
Samson Cordage Works.
Waterbury Co.
Whitlock Cordage Co.

Cork Cement.
Ferdinand, L. W., & Co.

Corrugated Furnaces.
American Spiral Pipe Works.
Continental Iron Works, The.

Cotton Duck.
(See Duck.)

Cotton Rubber-Lined Hose.
(See Hose.)

Counters.
(See Revolution Counters.)

Coverings—Non-conducting.
(See Non-Conducting Covering.)

Cranes.
(Also see Floating Cranes and Shipyard Whirlers.)
American Engineering Co.
Brown Hoisting Machinery Co.
Byers Machine Co., John F.
Dravo-Doyle Co.
Link-Belt Co.
McMyler-Interstate Co., The.
Manitowoc Ship Building Co.
Manning, Maxwell & Moore.
Niles-Bement-Pond Co.
Shepard Elec. Crane & Hoist Co.
Welin Marine Equipment Co.

Crank Shafts.
(See Forgings.)

Cutters.
Morse Twist Drill & Machine Co.

Cutting and Welding.
(See Welding.)

Cylinder Boring Bars.
Niles-Bement-Pond Co.

Cylinder Relief Valves.
(See Valves.)

Cylinders for Compressed Air, Gas, Etc.
Continental Iron Works, The.
National Tube Co.
Riverside Boiler Works.

Davits.
Steward Davit & Equipment Corp.
Welin Marine Equipment Co.

Deck Hoists.
(See Hoisting Engines.)

Deck Plates.
Sands, A. B., & Son Co.
Williams, William E.

Deck Pumps.
(See Pumps.)

Diaphragm Pumps.
(See Pumps.)
Hyde Windlass Co.

Dies.
Cleveland Steel Tool Co.
Morse Twist Drill & Machine Co.
Williams, William E.

Diesel Engines.
(Also see Oil Engines.)
Craig Engine & Machine Works.
Kearfott Engineering Co.
McIntosh & Seymour Corp.
New London Ship & Engine Co.

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THE *MODERN* DECKING

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Far superior to wood or cement.
Light in weight—artistic—sanitary—watertight—fireproof.

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Eckliff Circulator Co.
Welin Marine Equipment Co.

Distillers.
(See Evaporators.)

Diving Apparatus.
Morse, Andrew J., & Son, Inc.

Draft, Mechanical.
(See Mechanical Draft.)

Draft Gauges.
McNab Co., The.
Williams, William E.

Drafting Instruments.
Pease Co., C. F.
Starrett, L. S., Co.
Weber & Co., F.

Drain Valves.
(See Valves.)

Drawing Materials.
American Lead Pencil Co.
Dixon Crucible Co., Joseph.
Pease Co., C. F.
Starrett, L. S., Co.
Weber & Co., F.

Drawing Pencils.
American Lead Pencil Co.
Dixon Crucible Co.
Weber & Co., F.

Dredges.
Manitowoc Ship Building Co.

Dredging Machinery.
Alberger Pump & Condenser Co.
American Engineering Co.
Fletcher, W. & A.

Drilling Machines.
Niles-Bement-Pond Co.

Drills.
Morse Twist Drill & Machine Co.
Williams, William E.

Drills, Electric.
(See Electric Drills.)

Drills, Pneumatic.
(See Air Drills.)

Drills, Portable.
(See Portable Drills.)

Drop Forgings.
(Eye Bolts, Wrenches, Etc.)
Camden Forge Co.
Williams & Co., J. H.
Williams, William E.

Drop Hammers.
Beaudry & Co., Inc.
Chambersburg Engineering Co.
Niles-Bement-Pond Co.
United Hammer Co.

Dry Docks and Marine Railways.
Baltimore Dry Docks & Shipbuilding Co.
California Shipbuilding Co.
Merrill-Stevens Co.
Newport News Shipbuilding & Dry Dock Co.
Tietjen & Lang Dry Dock Co.
Union Dry Dock and Repair Co.
Valk & Murdoch Co.

Dry Docks.
(Marine Railway, Manufacturer.)
Crandall Eng. Co.

Drying Apparatus.
American Blower Co.

Dynamic Balancing.
Akimoff, N. W.

Dynamos.
(See Electric Plants.)

Economizers, Fuel.
(See Fuel Economizers.)

Ejectors.
Lunkenheimer Co.
Schutte & Körting Co.
Williams, William E.

Electric Drills.
Chicago Pneumatic Tool Co.
General Electric Co.
Independent Pneumatic Tool Co.
Williams, William E.

Electric Freight Trucks.
(See Freight-Handling.)

Electric Heaters.
General Electric Co.
Williams, William E.

Electric Hoists.
American Engineering Co.
General Electric Co.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Link-Belt Co.
Mead-Morrison Mfg. Co.
Mundy, J. S., Hoisting Engine Co.
National Hoisting Engine Co.
Niles-Bement-Pond Co.
Shepard Elec. Crane & Hoist Co.

Electric Lights.
Crouse-Hinds Co.
Engberg's Electric & Mechanical Works.
General Electric Co.

Electric Plants.
Engberg's Electric & Mechanical Works.
Gas Engine & Power Co. and Chas. L. Seabury Co., Consol.
General Electric Co.
Terry Steam Turbine Co.
Westinghouse Electric & Mfg. Co.

Electrical Fittings and Supplies.
Crouse-Hinds Co.
Engberg's Electric & Mechanical Works.
General Electric Co.
Goldie & McCulloch Co., Ltd.
Griscom-Russell Co.
Livingston & Co., J.

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General Electric Co.
Weston Electrical Instrument Co.

Elevating and Conveying Equipment.
Link-Belt Co.
Otis Elevator Co.

Elevators
(For Docks and Wharves.)
Link-Belt Co.
Otis Elevator Co.

Engine Logs.
Cummings Ship Instrument Wks.
McNab Co., The.

Engine Oil.
(See Lubricants.)

Engine Packing.
(See Packing.)

Engine-Room Clocks.
(See Clocks.)

Engine-Room Supplies.
(See Steam Specialties.)

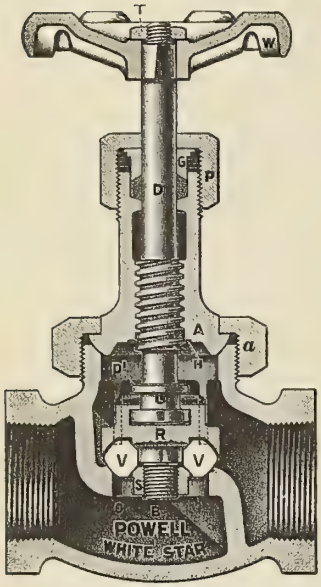
Engineers, Consulting.
American Engineering Co.
Bogert, John L.
Cox & Stevens.
Donnelly, W. T.
Farley, Edward P., Co.
Griscom-Russell Co.
Hough, Edward S.
Maxwell, Earl C., Co.
Rodberg, A. M.
Row & Davis, Engineers.
Union Dry Dock & Repair Co.
Watts, J. Murray.
Young, Rakestraw & Ferguson.

Engines for Auxiliaries.
Alberger Pump & Condenser Co.
American Blower Co.
American Engineering Co.
Connor, W. B., Inc.
Craig Engine & Machine Works, James.
De Laval Steam Turbine Co.
Engberg's Electric & Mechanical Works.
Fairbanks, Morse & Co.
Gas Engine & Power Co. and Chas. L. Seabury & Co.
Goldie & McCulloch Co., Ltd.
Hyde Windlass Co.
Kearfott Engineering Co.
McIntosh & Seymour Corp
Mietz Corporation, August.
Montague Iron Works.
Morris Machine Works.
New London Ship & Engine Co.
Remington Oil Engine Co.
Skandia Oil Engines

"White Star" Booklet on Request.

POWELL VALVES

(Especially The "White Star" Valve)



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Here Are Five Good Reasons Why You Should Use Powell Valves Especially the "White Star" Valve

Because	First	A good salesman may make a first sale to you, but after that POWELL VALVES require little salesmanship.
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Because	Third	The Engineer who installs POWELL VALVES, especially the "White Star" Valve, eliminates all his valve troubles.
Because	Fourth	Engineers find our claims for POWELL VALVES to be as represented in our catalogue.
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Wheeler Mfg. Co., C. H.
Winton Engine Works.

Engines, Gasoline.
(See Gasoline Engines.)

Engines, Hoisting.
(See Hoisting Engines.)

Engines, Kerosene.
(See Kerosene Engines.)

Engines, Oil.
(Also see Diesel Engines.)
Bolinder's Company.
Craig Engine & Machine Works, James.
Connor, W. B., Inc.
Fairbanks, Morse & Co.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
McIntosh & Seymour Corp.
Mietz Corporation, August.
New London Ship & Engine Co.
Remington Oil Engine Co.
Skandia Oil Engines.
Standard Motor Construction Co.
Winton Engine Works.
Wolverine Motor Works.

Engines, Propelling.
Bolinder's Company.
Craig Engine & Machine Works, James.
Fairbanks, Morse & Co.
Fletcher, W. & A., Co.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
Goldie & McCulloch Co., Ltd.
Kearfott Engineering Co.
McIntosh & Seymour Corp.
Manitowoc Ship Building Co.
Mietz Corporation, August.
Montague Iron Works.
Moore & Sons Corp., S. L.
Morris Machine Works.
New London Ship & Engine Co.
Parsons Mar. Steam Turbine Co.
Remington Oil Engine Co.
Sheriffs Mfg. Co.
Skandia Oil Engines.
Standard Motor Construction Co.
Trout, H. G., Co.
Ward, Chas., Engineering Works.
Winton Engine Works.
Wolverine Motor Works.

Engines, Pumping.
Alberger Pump & Condenser Co.
Davidson, M. T., Co.
Griscom-Russell Co.
Morris Machine Works.
Remington Oil Engine Co.
Row & Davis, Engineers, Inc.
Terry Steam Turbine Co.
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Engine-Room Clocks.
(See Clocks.)

Engine Room Gratings.
Irving Iron Works Co.

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Alberger Pump & Condenser Co.
American Engineering Co.
Davidson, M. T., Co.
Griscom-Russell Co.
Kearfott Engineering Co.
Row & Davis, Engineers, Inc.
Schutte & Körting Co.

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Expanders.
(See Boiler Flue Expanders.)

Expansion Joints.
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Crane Co.
Griscom-Russell Co.
Lunkenheimer Co.
National Tube Co.
Williams, William F.
Wheeler Mfg. Co., C. H.

Fans.
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Feed Check Valves.
(See Valves.)

Feed Water Heaters.
Connor, W. B., Inc.
Griscom-Russell Co.
Row & Davis, Engineers, Inc.
Wheeler Mfg. Co., C. H.

Feed-Water Regulators.
Alberger Pump & Condenser Co.
Kearfott Engineering Co.
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Ferrules—Condenser Tube.
(See Condenser Tube Ferrules.)

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Nicholson File Co.

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Pease Co., C. F.

Filters.
Griscom-Russell Co., New York.
Kearfott Engineering Co.
Row & Davis, Engineers, Inc.
Schutte & Körting Co.
Wheeler Mfg. Co., C. H.

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Morse, Andrew J., & Son, Inc.

Fire Extinguishers.
Morse, Andrew J., Son, Inc.
Williams, William E.

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(See Hose.)

Fireproof Construction.
Asbestos Protected Metal Co.

Fireproof Lumber.
(See Lumber, Fireproof.)

Fire Pumps.
(See Pumps.)

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American Spiral Pipe Works.
Crane Co.
Dart, E. M., Mfg. Co.
Lunkenheimer Co.
National Tube Co.
Williams Valve Co., D. T.
Williams, William E.

Filing Cabinets.
Pease Co., C. F.

Flanging Machines.
Niles-Bement-Pond Co.

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(Also see Cranes.)
Manitowoc Ship Building & Dry Dock Co.

Floating Dry Docks.
(See Dry Docks.)

Floor Gratings
Irving Iron Works Co.

Floor Plates.
Crane Co.

Flue Cleaners.
(See Boiler Flue Cleaners.)

Flue Cutters.
(See Boiler Flue Cutters.)

Flue Hole Punches and Dies.
Covington Machine Co.

Forced Draft.
(See also Blowers.)
American Blower Co.
De Laval Steam Turbine Co.
General Electric Co.
Terry Steam Turbine Co.
Westinghouse Machine Co.

Forges.
Beach-Russ Co.
Buffalo Forge Co.
Metals Production Equipment Co.

Forgings, Bronze.
(See also Drop Forgings.)
Camden Forge Co.
Hyde Windlass Co.

Forgings, Iron and Steel.
Camden Forge Co.
Valk & Murdoch Co.

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Byers Machine Co., John F.
Dravo-Doyle Co.
Lidgerwood Mfg. Co.
Link-Belt Co.
McMyler-Interstate Co., The.
Manning, Maxwell & Moore.
Mead-Morrison Mfg. Co.
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National Hoisting Engine Co.
Otis Elevator Co.
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Griscom-Russell Co.

Fuel Oil Burners.
Schutte & Körting Co.

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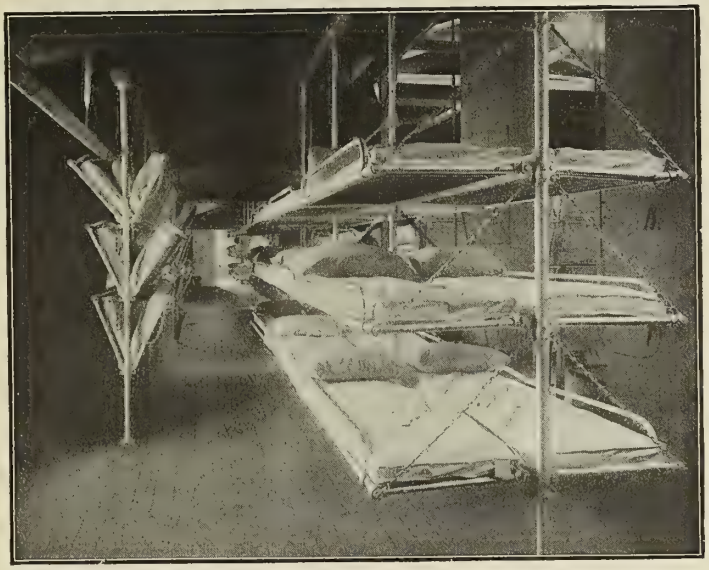

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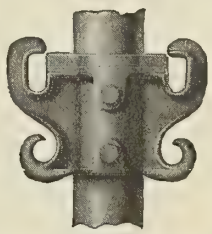
"STANDEE BERTHS ONE OF OUR SPECIALTIES." We have built them in quantities for the largest shipbuilders in the U. S.

Manufactured in their entirety in a plant which is one of the oldest, largest and best equipped metallic bed and bedding factories in the country.

A complete practical and efficient line is offered. "A berth to successfully meet every condition on board ship." Also brass and iron beds, mattresses and pillows.

We describe them fully in a catalog which should be on your files. WRITE FOR IT — SPECIFYING CATALOG NO. 17.



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Continental Iron Works, The.

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Lunkenheimer Co.
National Tube Co.
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Williams Valve Co., D. T.
Williams, William E.

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Powell, Wm., Co.
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Williams Valve Co., D. T.
Williams, William E.

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Jerguson Gage & Valve Co.
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Williams, William E.

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Link-Belt Co.
Westinghouse Electric & Mfg. Co.

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(See Electric Plants.)

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Dixon, Jos., Crucible Co.

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(For Cylindrical Grinding.)
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Hyde Windlass Co.

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(See Pneumatic Tools.)

Hammers, Power.
Beaudry & Co., Inc.
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Hammers, Steam.
(See Steam Hammers.)

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Sands, A. B., & Son Co.
Schutte & Körting Co.
Sturtevant Co., B. F.

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American Blower Co.
Schutte & Körting Co.
Sturtevant Co., B. F.

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(See Twine.)

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American Engineering Co.
Dake Engine Co.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Mead-Morrison Mfg. Co.
Mundy, J. S., Hoisting Engine Co.
National Hoisting Engine Co.

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(See Rope.)

Hoists, Chain.
(See Chain Hoists.)

Hoists, Electric.
(See Electric Hoists.)

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Covington Machine Co.

Hose.
(Also see Air Hose.)
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Morse, Andrew J., Son, Inc.

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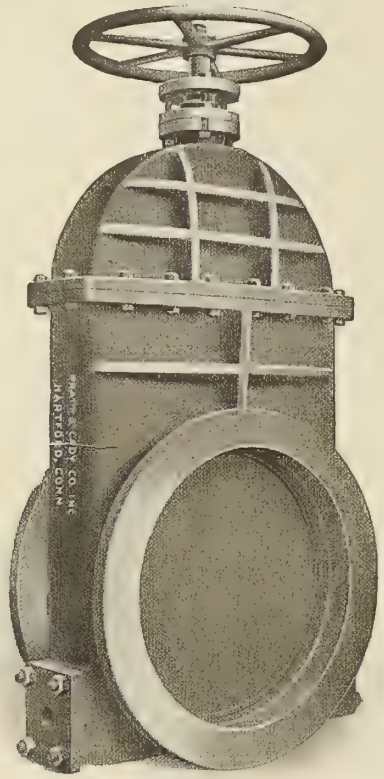
Crane Co.
Lunkenheimer Co.
National Tube Co.
Powell, Wm., Co.
Schutte & Körting Co.

Hydraulic Machinery.
Chambersburg Engineering Co.
Niles-Bement-Pond Co.



Pratt & Cady Double Disc Parallel Seat Gate Valve with Cleanout.

Gate Valves for Tank Steamers

This is an illustration of a Pratt and Cady, Double Disc, Parallel Seat, Gate Valve with a Clean-out especially adapted for oil lines in Tankers.

The double disc construction, with a wedging mechanism between the discs, insures a positively tight joint.

They are made either of all iron, or with an iron body and bronze spindles, bronze seat rings and bronze disc faces, in all the sizes required for this service.

Ask us for further particulars of why they give perfect satisfaction on oil-carrying vessels.

Pratt & Cady Co., Inc.

Hartford, Conn.

Makers of Valves, Cocks and Steam Traps

Hydrogen.
International Oxygen Co.

Ice Detectors.
McNab Co., The

Ice Machines.
(See Refrigerating Machinery.)

Indicator Connections.
Lunkenheimer Co.

Indicators.
(Steam and Gas Engine.)
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Ashton Valve Co.
Lunkenheimer Co.
Manning, Maxwell & Moore.
Powell Co., The, William.

Induced Draft.
American Blower Co.

Injectors.
Lunkenheimer Co.
Manning, Maxwell & Moore.
Powell Co., The, William.
Schutte & Körting Co.

Interlocking Rubber Tiling.
Griscom-Russell Co.

Iron Cement.
Smooth-On Mfg. Co.

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Asbestos Protected Metal Co.

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(Pneumatic.)
Independent Pneumatic Tool Co.

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(See Thrust Bearings.)

Jute.
Columbian Rope Co.

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Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
Mietz Machine Works, August.
Remington Oil Engine Co.
Standard Motor Construction Co.
Wolverine Motor Works.

Ladders.
Irving Iron Works Co.

Ladder Treads.
Irving Iron Works Co.

Lagoline for Engine Rooms.
International Compositions Co.

Lamps, Signals and Fixtures.
General Electric Co.

Lath, Asbestos.
Asbestos Protected Metal Co.

Lath, Metal.
Asbestos Protected Metal Co.

Lathes, Crank Shaft.
Niles-Bement-Pond Co.

Lathes, Engine.
Niles-Bement-Pond Co.

Lathes, Turret.
Niles-Bement-Pond Co.

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Baltimore Dry Docks & Shipbuilding Co.
California Shipbuilding Co.
Gas Engine & Power Co. and Chas. L. Seabury & Co., Consol.
Manitowoc Ship Building Co.
Moore & Sons Corp., S. L.
New London Ship & Engine Co.
Peninsula Shipbuilding Co.
Standard Motor Construction Co.
Sun Shipbuilding Co.
Valk & Murdoch Co.
Ward, Chas., Engineering Works.
Welin Marine Equipment Co.
Wolverine Motor Works.

Lavatories.
(Stateroom.)
Mott Iron Works, J. L.
Sands, A. B., & Son Co.
Williams, William E.

Lavatory and Bath Heaters.
Griscom-Russell Co.
Schutte & Körting Co.

Lead Pencils.
(See Pencils.)

Life Boats and Rafts.
Galbraith, C. C., & Son.
Lane Life Boat Co., C. M.
Welin Marine Equipment Co.
Williams, William E.

Life Preservers.
Ferdinand, L. W., & Co.
Galbraith, C. C., & Son.
Welin Marine Equipment Co.
Williams, William E.

Life-Saving Devices.
Galbraith, C. C., & Son.
Steward Davit & Equipment Corp.
Welin Marine Equipment Co.
Williams, William E.

Lines—Towing, Buoy
(See Rope.)

Liquid Glue, Waterproof.
Ferdinand, L. W., & Co.

Loading and Unloading Equipment.
(See Freight Handling Equipment.)

Locomotive Cranes.
(See Cranes.)

Log Registers.
Cummings Ship Instrument Wks.
McNab Co., The.
Welin Marine Equipment Co.

Lubricants.
Albany Lubricating Co.
Dixon, Jos., Crucible Co.
Sun Co.
Williams, William E.

Lubricating Compound.
Albany Lubricating Co.
Sun Co.
Williams, William E.

Lubricating Oil.
Sun Co.

Lubricators.
Albany Lubricating Co.
Crane Co.
Griscom-Russell Co.
Kelly & Jones Co.
Lunkenheimer Co.
Powell, Wm., Co.
Schutte & Körting Co.
Sun Co
Williams Valve Co., D. T.
Williams, William E.

Lumber.
Long-Bell Lumber Co.
Southern Pine Association.

Machine Tools.
(See Tools, Machine.)

Machinery—Second-Hand.
(See Second Hand Machinery.)

Manganese Bronze Castings.
Griscom-Russell Co.
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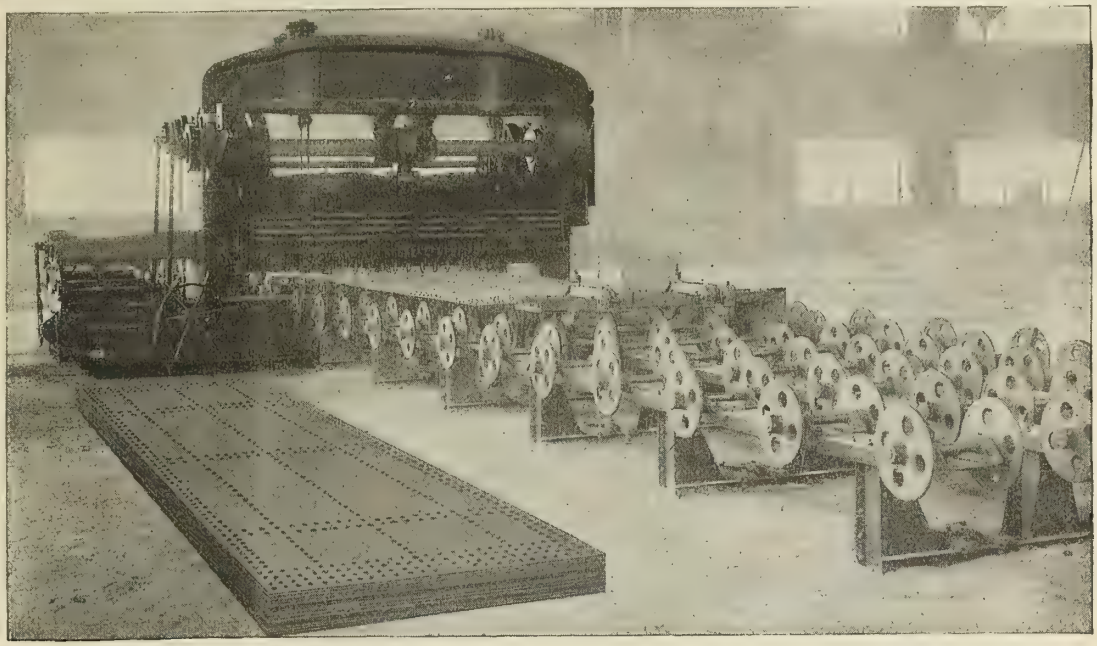

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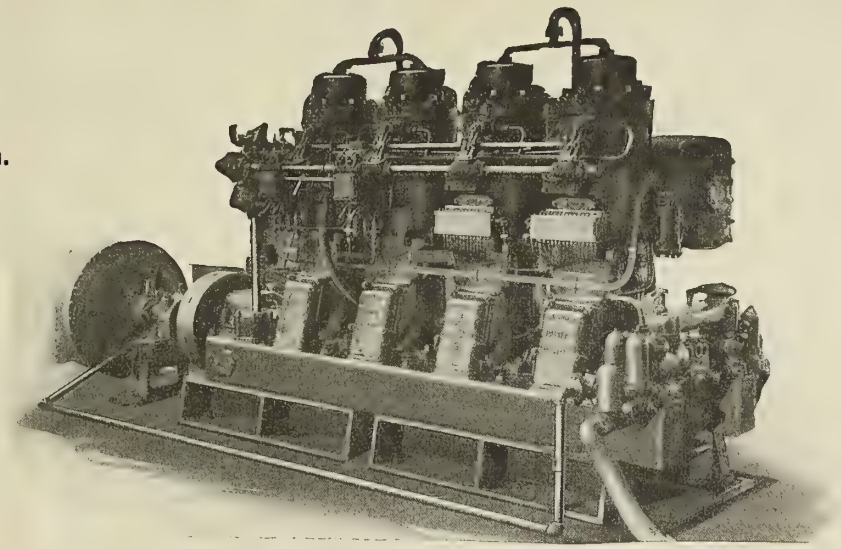

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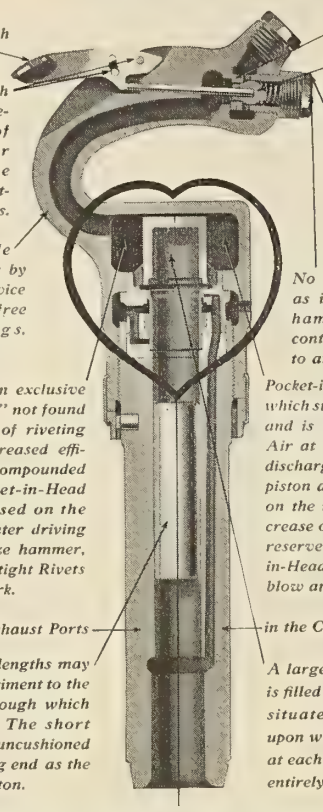

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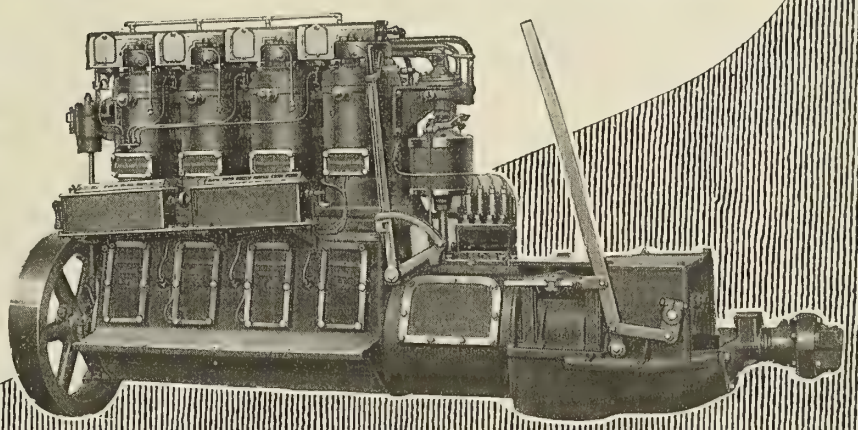

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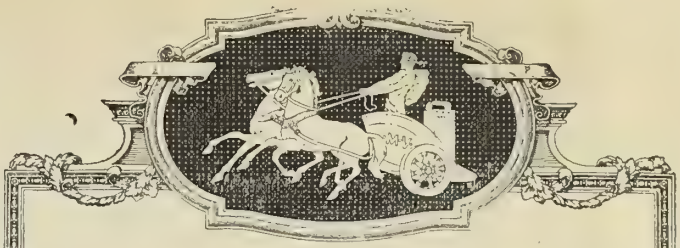

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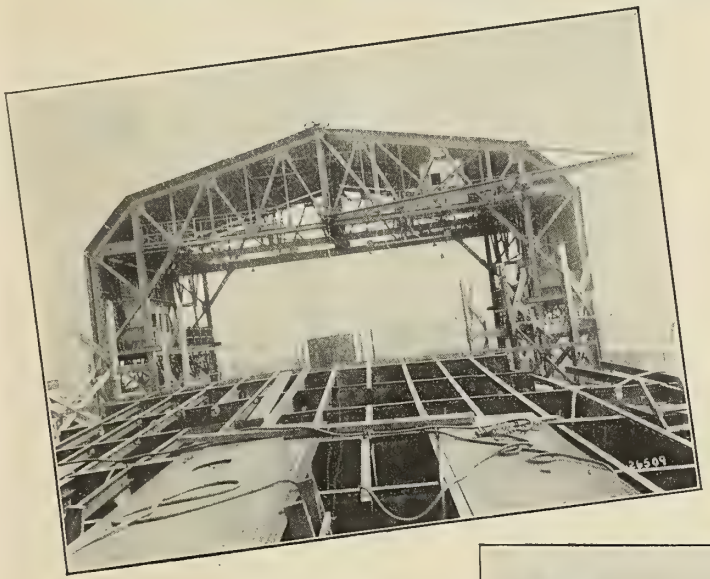
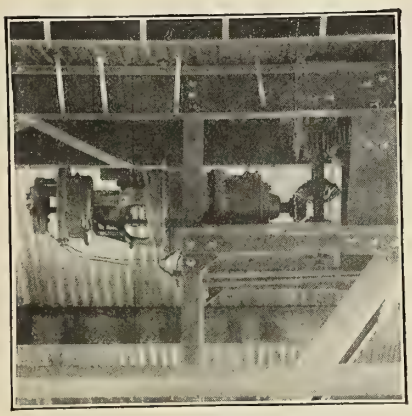
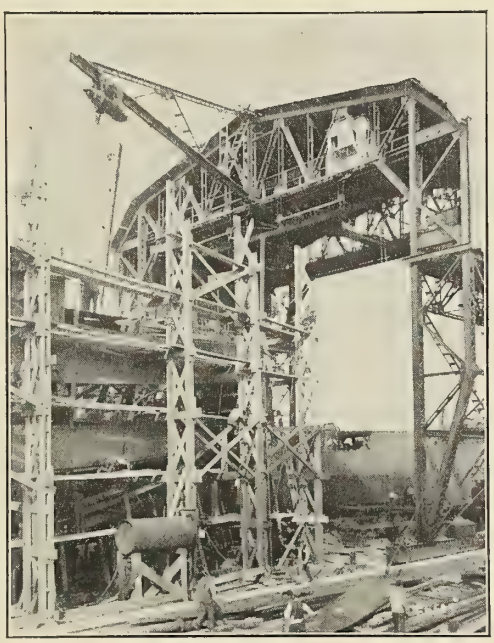
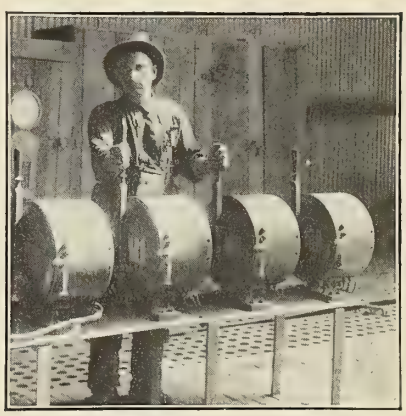




Back Geared Motor for rotating Boom of Jib Crane





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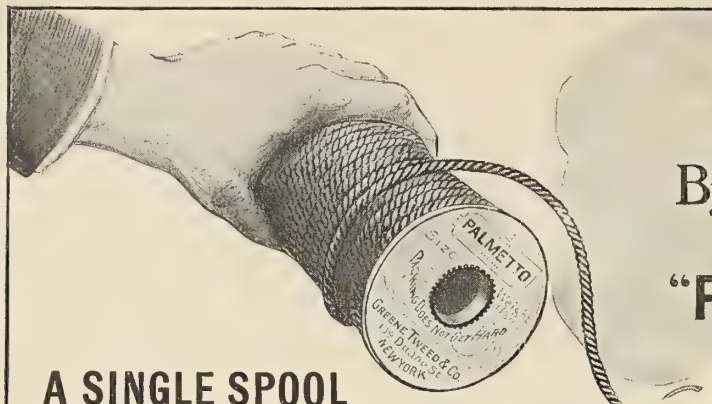

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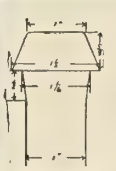
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